JUNE 50¢

Radio-Electronics

LEVISION · SERVICING · HIGH FIDELITY

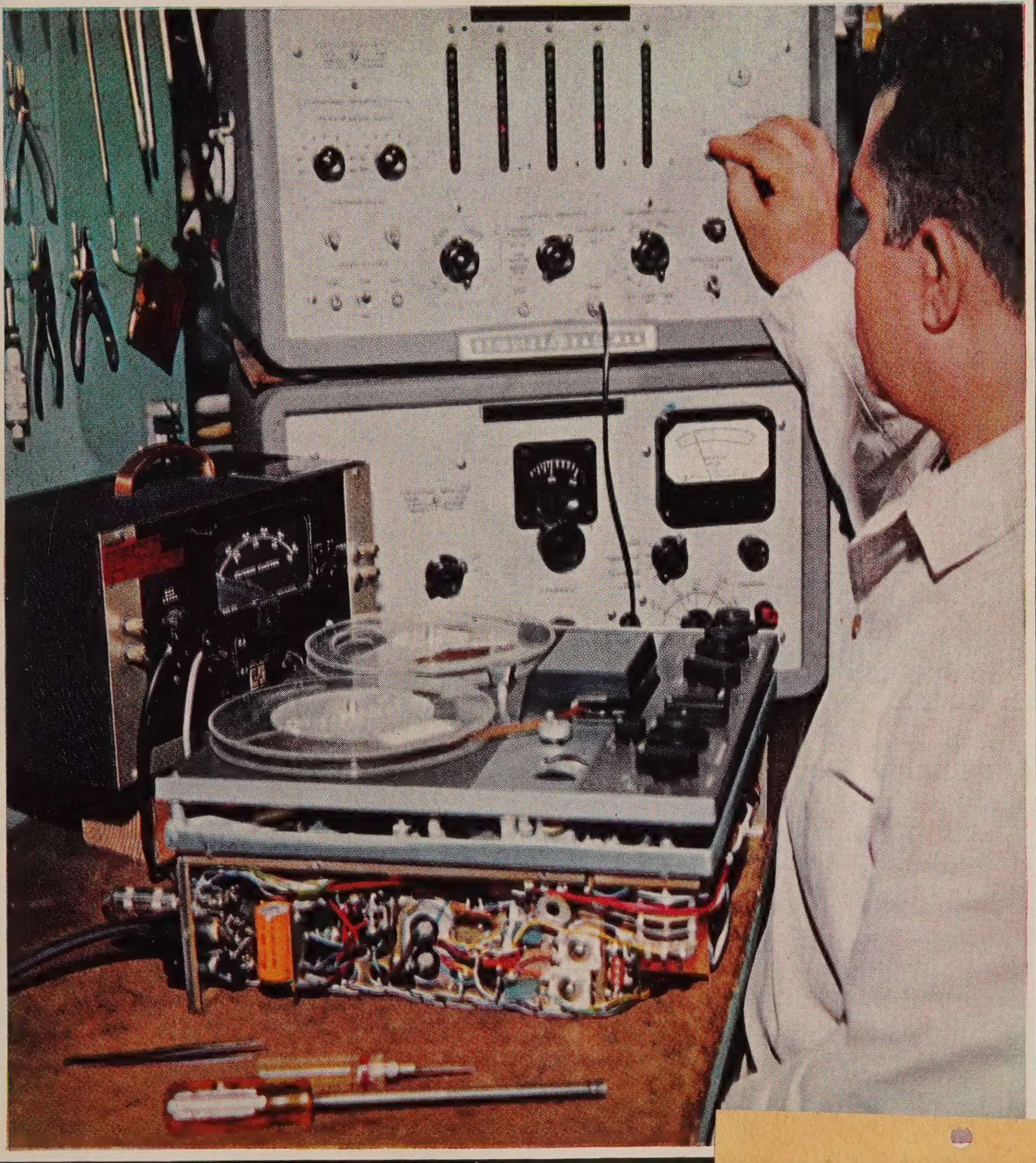
A GERNSBACK PUBLICATION

ontrol High Power ith Transistors

Five SCR Circuits For Experimenters

Recondition Old TV's For Better Profits

HUGO GERNSBACK, Editor-in-chie



Specialized Test Equipment Pays Off in Hi-Fi Service

See page 40

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Radio-Electronics

JUNE 1964 VOL. XXXV NO. 6

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SEMI-ANNUAL INDEX

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GENERAL

RADIO

TELEVISION

TEST INSTRUMENTS

THE DEPARTMENTS

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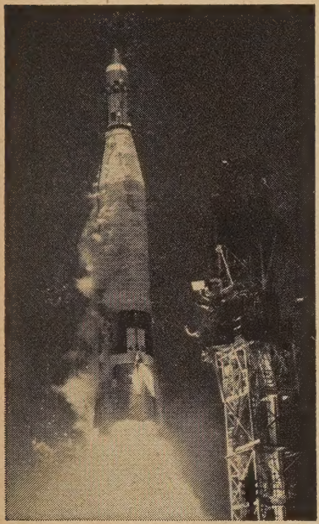

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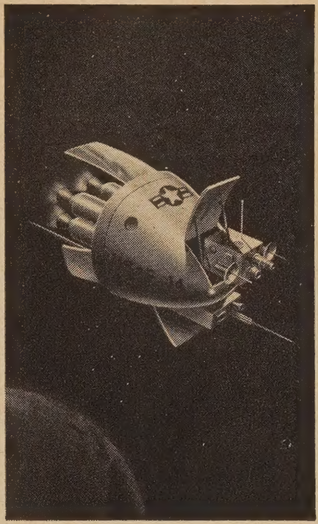

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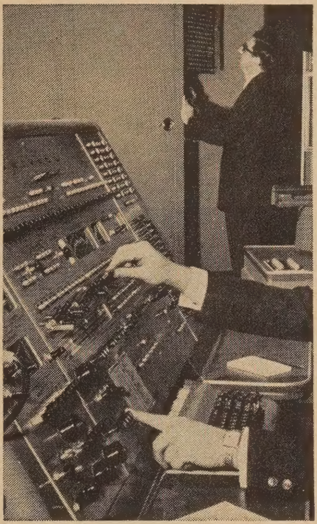

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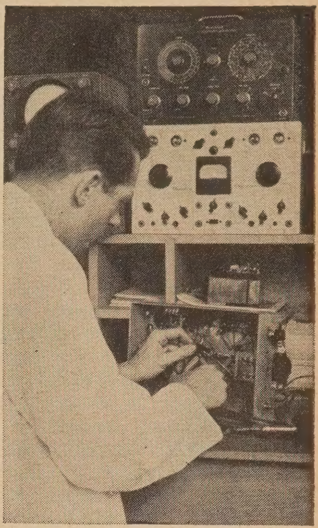

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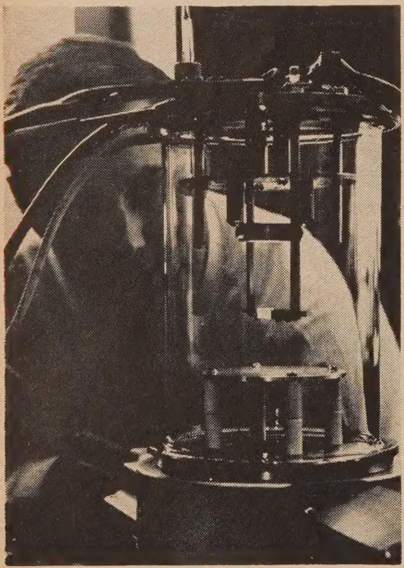
NEWS BRIEFS

New Ultrasonic Transducers Work to 1,000 Megacycles

Two new types of ultrasonic transducers, made of cadmium sulfide, have been developed by Dr. Norman Foster of Bell Telephone Labs. The devices, Dr. Foster says, are more efficient and have greater bandwidths than other transducers in the 100- to 1,000-mc range.

A diffusion-layer transducer, one of the new types, is made by diffusing copper from an evaporated copper electrode into a conductive cadmium sulfide block. The copper impurity in a thin surface layer produces a high-resistivity region across which the electric field necessary for piezoelectric transducer action is developed. The cadmium sulfide block is large enough to need no bonding.



Dr. Foster and the vacuum-deposition equipment used in producing evaporated-layer ultrasonic transducers.

The other kind, an evaporated-layer transducer, is formed by depositing a thin layer (up to 7 microns thick) of cadmium sulfide on a suitable ultrasonic propagation material such as quartz. The cadmium sulfide film is evaporated in vacuum onto the heated surface of a quartz bar, which has been previously plated with a conductive coating such as copper. To reduce conductivity of the cadmium sulfide film, it is overplated with copper and subjected to a heat treatment which causes the films to recrystalize, increasing the resistivity. The film can now act as a piezoelectric transducer.

Fairchild photo

Wayne R. Johnson, Vice President and Technical Director of Winston Research Corp. looks over the new TV tape recorder. Slightly modified conventional TV receiver is off-the-air signal source and playback monitor. Camera is for live recordings.

Home TV Recorder Around The Corner

A revolutionary home TV tape recorder that can be on the market by Christmas 1965 has been developed by Winston Research Corp., a subsidiary of Fairchild Camera & Instrument Corp. Technical writers and members of the press agreed that its performance is quite acceptable and comparable to a professional machine.

Estimated cost will be $500 or less. With a small portable TV camera costing around $150, home movie fans could take hour-long movies and play them back immediately through the recorder and TV set. Housewives could record off-the-air programs during a busy time of the day and play them back at a more convenient time. Cost of an hour-long tape ($15 to $25, depending on production volume) would be considerably less than for an equivalent 8-mm home movie.

The recorder uses ¼-inch tape moving at 120 ips across stationary playback and recording heads. It takes 11-inch, 9,000-foot reels of 0.5-mil instrumentation-quality tape. There are four tracks. Each records 15 minutes. The recorder automatically reverses itself at the end of each track, records in the opposite direction and cuts off automatically when the four tracks have been recorded.

Video response is flat to 2 mc. Video, audio and sync signals are tapped off a conventional receiver and fed to the recorder electronics. Multiplexing fits all information on the same track. On playback, the signals from the tape are split and fed to corresponding receiver circuits. A TV service technician or skilled electronic experimenter can adapt almost any TV set to the recorder.

The electronics in the laboratory model uses 50 entertainment-type silicon transistors. This may be reduced 25 to 35% in production models.

New Computer System Is World's Most Flexible

A computer system which offers a configuration tailored to meet the needs of any user, from the smallest to one requiring a system bigger than the world's present largest computer, was revealed by International Business Machines at its Poughkeepsie plant.

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IBM board chairman Thomas J. Watson, Jr., called the event the most important product announcement in the company's history. The announcement was in keeping with the company's estimate of the product's importance. There was an all-day press conference at Poughkeepsie, with press people from all parts of the continent, some brought by special train from New York City. At the same time, conferences were held in large cities throughout the United States and other countries in which IBM has headquarters.

System 360, as the new computer is called, spans the performance range of present IBM computers. It uses combinations of internal and external equipment, which can be tailored into a configuration to suit almost any user. Possible combinations in the central processer number 19, and more than 40 types of input and output equipment can be combined with these. The processing power of the largest configuration is approximately 50 times greater than the smallest.

This is reflected in the rentals, the lowest suggested one being $2,700 per month, and the highest about $115,000, with comparable purchase prices from $133,000 to $5,500,000. Deliveries are expected to begin in the third quarter of 1965.

The system uses an interesting type of small integrated-circuit module, in which glass-protected transistor or diode chips are added to prefabricated circuit units.

Tells Engineers How To Avoid Obsolescence

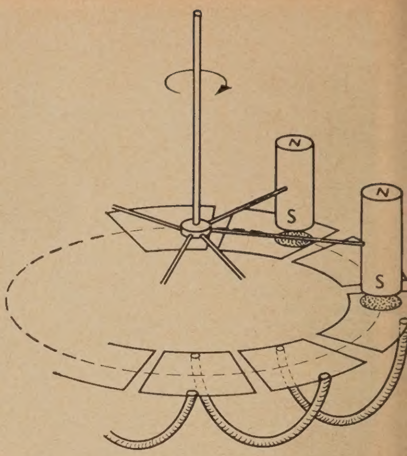
Engineers do not have to worry about technical obsolescence if they simply keep on going to school for some 40 years *after* receiving their engineering degree. This secret was revealed to engineers of the IEEE by E. H. Freiburghouse of General Electric, in a panel discussion on electrical engineering education at the recent IEEE Convention.

Our highly industrialized, technically based society, Mr. Freiburghouse has said, must abandon its concept of "sequential" lives in which 16 or 20 years of school is followed by 40 years of work and 20 years of retirement. The modern—and necessary—pattern will be 16 or 20 years of school followed by 40 years of work *and* school.

Superconductive Generator Produces Huge Currents

An electric generator, operating at the Westinghouse Research Laboratory, is supplying 800 amperes of electric current, used to energize large superconducting magnets. The remarkable thing about the generator is that it is only 4 inches in diameter.

The reason for this astonishing performance is that the generator is



made of superconducting materi[al] having no resistance. As shown i[n] the drawing, the generator is a serie[s] of flat plates of niobium, or othe[r] superconducting material, connecte[d] together by superconducting wire. [A] group of permanent magnets rotate above the plates, creating a magneti[c] field that sets up a current in the con[-]ductors. The whole equipment is op[-]erated inside a vessel of liquid heliur[m] at −455°F.

Another version of the generato[r] uses electromagnets instead of per[-]manent ones, and an alternating cur[-]rent to produce a rotating magneti[c] field as in an ac motor. This make[s] a superconducting generator with n[o] moving parts.

CALENDAR OF EVENTS

International Instruments, Electronics & Autom[a]tion Exhibition, May 25–30; Olympia, Londo[n] England.

10th Annual Radar Symposium, May 26–28; Fo[rt] Monmouth, N. J.

International Symposium on Global Communic[a]tions (GLOBECOM VI), June 2–4; University of Pennsy[l]vania and Sheraton Hotel, Philadelphia, Pa.

National Telemetering Conference, June 2–4; Bil[t]more Hotel, Los Angeles, Calif.

Symposium on Quasi-Optics, June 8–10; Statle[r] Hilton Hotel, New York, N. Y.

6th National Symposium on Electromagnetic Com[-]patability, June 9–11; Los Angeles, Calif.

Chicago Spring Conference on Broadcast & TV Re[-]ceivers, June 15–16; O'Hare Inn, Des Plaines, Ill.

1964 Conference on Precision Electromagnet[ic] Measurements, June 16–18; National Bureau of Stan[d]ards, Boulder, Colo.

San Fernando Valley Radio Club Hamfest an[d] Picnic, June 21; Sunset Farms, Sylmar, Calif.

Statewide CB Jamboree, Naugatuck Valley CB Radi[o] Club, June 21; Lake Quassapaug Pavilion, Route 6-A Middlebury, Conn.

Conference on Precision Electromagnetic Measure[-]ments, June 23-25; National Bureau of Standards Lab[-]oratories, Boulder, Colo.

"Indefinable Something" —High Fidelity?

The high-fidelity components in[-]dustry has decided "regretfully" tha[t] it is impossible at this time to defin[e] high fidelity. The statement come[s] from Victor Pomper, executive vic[e] president of H. H. Scott, Inc., an[d] a director of the Institute of Hig[h] Fidelity, Inc.

MALLORY

Tips for Technicians

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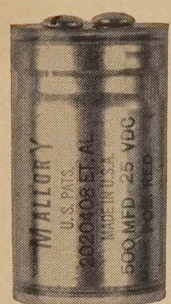
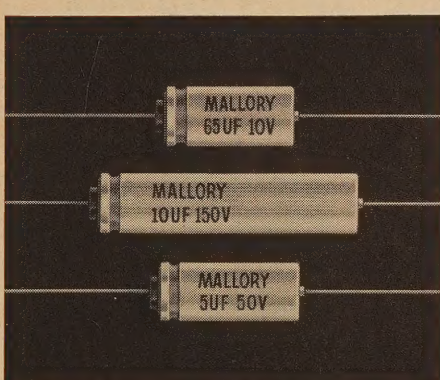
How to select high-reliability capacitors



Computer Grade Capacitor



▲ Type TPG Capacitors

Metallized Mylar* Capacitors

Much of today's electronic gear is used in places where a shutdown because of failure can be astronomically expensive—or it could be downright dangerous to life and limb. In these places it is essential that high reliability components be used. But how does one select truly highly reliable components? The surest method is to bank on the reputation of the manufacturer and to have an intimate knowledge of types of products available.

Take the case of tubular electrolytic capacitors. The standard Mallory TC type has been used for years in literally millions of radios and TV sets with unparalleled success. But the new TPG (Tubular Premium Grade) type is engineered and manufactured to vastly more critical standards. These standards apply to the aluminum foil, to the electrolyte, the all-welded construction, safety vent, and to the extra testing required.

Then there are computer grade filter capacitors. Mallory computer grade types have proven their ability to be better than new after twenty years of continuous service. Standard ratings are available "off-the-shelf" up to 115,000 mfd.

When it comes to Mylar* capacitors one may select from dipped, molded, wrapped, and umpteen other styles. There are dual-dielectrics, plain Mylar, Metallized Mylar, etc. Mallory PVC and the all-new GEM series utilize 100% Mylar dielectric, but these are commercial types. For high reliability applications, one needs the new ELECTRON metallized Mylar type available in up to 10 mfd @ 100 WVDC. And in the smallest package by volume available anywhere. ELECTRON capacitors are metallized with *aluminum* . . . not zinc as are virtually all other types. Capacitor cartridges are sealed in pre-molded cases with high-density epoxy and the cases are rectangular to better withstand vibration and occupy minimum space.

Tantalum capacitors to meet the most extreme standards of reliability are stock items with Mallory: solid electrolyte, plain and etched foil, wet slug types and 200°C high capacity types (even radiation resistant types).

Whenever you need a truly high reliability capacitor, call your Mallory Distributor. Just ask him for a copy of the 1964 Mallory General Catalog and you'll be able to make a selection from the hundreds of types listed.

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The consensus of the manufacturer members of the IHF is that it is impractical and impossible to arrive at a meaningful definition. Mr. Pomper likened the task to that of finding capsule definitions of "metaphysical" terms like "beauty" or "truth".

A definition of high fidelity, he said, "would do more harm than good for the industry and the public," and added that it would set boundaries for hi-fi performance. "I don't think high fidelity can be defined," he said.

Integration Slow But Sure In Electronics Field

Modular circuitry may well take over about 70% of the electronics used in military equipment and 50% of consumer equipment circuitry within the next 10 years.

That was the consensus of a panel that discussed expected technological advances during the next 10 years before an audience of 2,000 people at an evening session of the IEEE. The panel, consisting of Patrick Haggerty, Texas Instruments; J. E. Brown, Zenith; Leonard C. Maier, General Electric; Harry Knowles, Westinghouse; Robert Noyce, Fairchild Camera & Instrument, and Lester Hogan, Motorola, agreed that progress in the consumer field would be much slower than in the military, and did not expect to see much integrated circuitry in ordinary radios and TV sets for the next 3 or 4 years. Brown of Zenith pointed out, however, that Zenith had already introduced a hearing aid containing microminiature solid-state circuitry, and that the modular components increased the efficiency of the hearing aid while cutting its cost.

All agreed that the most immediate and the greatest advance would be in military equipment, since the reliability and small size of the integrated components adapts them particularly to military needs. They agreed also that, in the long run, solid-state integrated circuitry can be produced at lower cost than present-day conventional equipment. However, at the present time, cost is higher.

Tom Gootee Passes

Thomas Gootee, known to readers of this and other electronic magazines under both his own name and his pen-name, Jordon McQuay, died March 12. He had written a large number of articles for this magazine, including the first detailed description of the operation of radar to appear in an American magazine. He also wrote an early series on semiconductors and one on antennas. His more recent pieces were devoted to new developments in communications, both and in the military and civilian fields.

Before World War II, Mr. Gootee was an engineer in the studios of the National Broadcasting Company in Chicago. He was also an author of radio scripts and other fiction.

In World War II, he was one of the earliest group to be assigned to radar, and was sent to England early in the war for special radar training. Returning with the rank of lieutenant, he worked in the Signal Corps' Publications Agency at Fort Monmouth, and was especially active in an effort to improve the style and clarity of Signal Corps manuals and other publications. Retiring as Captain, he took a civilian position as Technical Information Officer in the office of the Chief Signal Officer at Washington, leaving only a few years ago to join a commercial engineering firm.

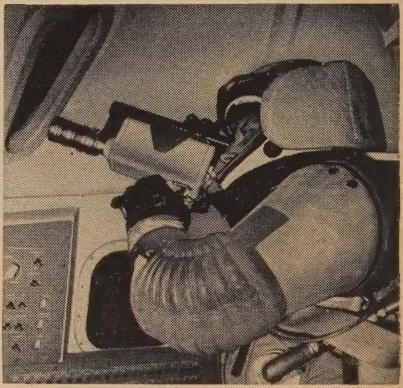
Computer Educator Hits Lag in Teaching Skills

The director of education at Honeywell Electronic Data Processing, Mr. Arnold E. Keller, says that while modern electronic office equipment demands greater sophistication and training, "our school systems largely content themselves with teaching the office skills of the quill and green-eyeshade era." As a result, graduates have to spend more time and money in private courses which, Mr. Keller said, can and should be included in the commercial high school curriculum.

Two factors in obsolescent skills training: lack of teacher knowledge of new equipment, and high cost of obtaining such equipment. Mr. Keller says that the new concepts of new machines can be taught now, and that "we eventually will find a way to move the equipment into the classroom."

Live TV from Moon Via Tiny Camera

Viewers on earth may get their first live TV closeup of the moon via a hand-held television camera being developed by RCA for the Apollo manned lunar mission.



Smaller than a carton of cigarettes and weighing 4¼ lb., the TV camera will use a 70° wide-angle lens for on-board viewing or a 90° to 35° zoom lens for scenes taken through a window of distant objects. It may be mounted in two positions in the command module, and installed in stations for different angles of the astronauts and spacecraft during lift-off, earth orbit, lunar trajectory and lunar orbit.

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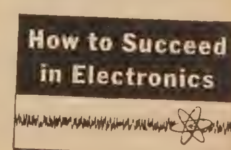

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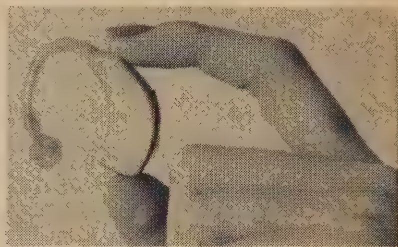
Power Sent by Radio Over 25-Foot Distance

Wireless-power transmission of several hundred watts was reported to the recent IEEE convention by W. C. Brown of Raytheon Co. In one experiment, an electric fan was operated at 25 feet by microwave power, transmitted from a parabolic antenna, picked up by an efficient receiving antenna and rectified by special high-efficiency semiconductor rectifiers. Today's technology, Mr. Brown stated, would probably allow sending more than 100,000 watts of power 5 miles through the air.

Integrated Circuit Used In Hearing Aid

The first hearing aid to use a microminiature circuit has been announced by Zenith.



Mr. E. M. Kinney, president of Zenith Hearing Aid Sales Corp., said the new amplifier was developed jointly by Zenith Radio and Texas Instruments, Inc. Solid-state circuitry, he said, "enables us to produce a six-transistor hearing aid weighing only $\frac{1}{4}$ oz, with battery." Ten of these tiny circuits can be stacked in a space the size of a safety-match head.

Size reduction permits such features in the new *Arcadia* aid as a coil that allows the user to hear telephone conversation without room noises.

Brief Briefs

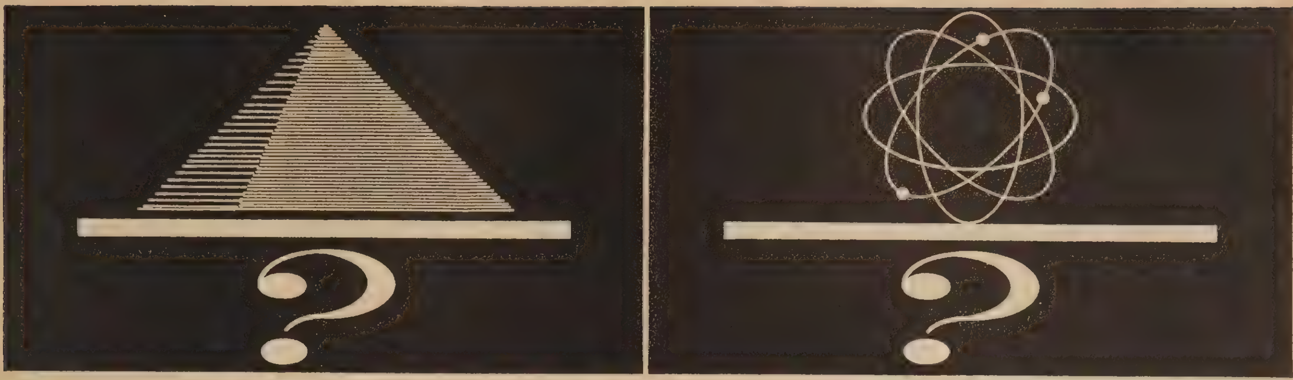
Laser light, used to detect tiny particles in the upper atmosphere, may be as important in weather prediction as radar, says Dr. Myron G. H. Ligda of Stanford Research Institute, Menlo Park, Calif.

Sony Corp. has been licensed to sell in the United States television sets and tubes using the Chromatron principle.

Texas Instruments announces silicone-encapsulated silicon transistors. These will replace epoxy-encapsulated transistors as well as more conventional types.

Ruby lasers are now being supplied for regular manufacturing work. The Sippican Corp. of Marion, Mass. is using a number of units developed by Lear Siegler for microwelding.

The Internation Space Conference has set up a distress frequency for spacemen—20.007 mc. END



WHAT IS THE COMMON DENOMINATOR OF AN ANCIENT EGYPTIAN PYRAMID AND A MODERN ELECTRONICS CAREER?

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Write for technical data or ask your Winegard distributor.

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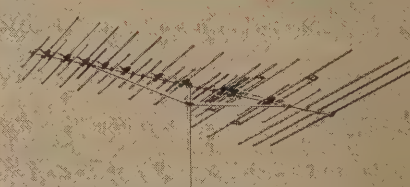

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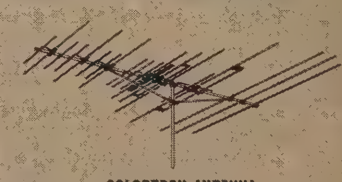

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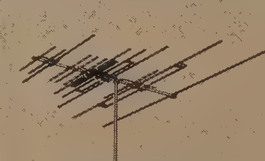
Model C-43 • Gold Anodized • $51.90



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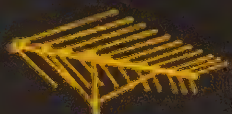
*MODEL	LIST
LPV17	$59.95
LPV14	49.95
LPV11	39.95
LPV8	29.95
LPV6	21.95
LPV4	14.95



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Exciting new Log-Periodic antennas from the JFD Antenna Research and Developmen Laboratories with the engineering advances to help you make the sales **others can't** i the complex new VHF/UHF/FM age.

NEW FROM THE NOTED JFD CHAMPAIGN, ILLINOIS LABORATORIES— NEW LOG-PERIODIC LPV ANTENNAS FOR ANY AND ALL BANDS... EVERY RECEPTION NEED!

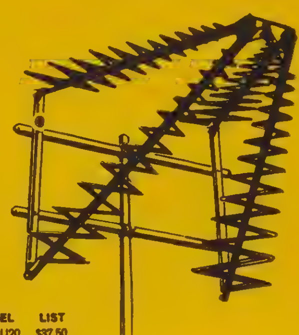
DEL	LIST
-VU22*	
-VU18	$ 69.95
-VU15	59.95
-VU12	49.95
-VU9*	

*to be announced

Model LPV-U15 (suburban-fringe) shown

EW! THE FIRST COMBINATION VHF/UHF/FM ANTENNA THE LOG-PERIODIC ALL-VU - WITH SINGLE LEAD-IN

morrow's antenna today. The most advanced applica- on of the Log-Periodic formula—receives all FCC au- orized television channels (VHF 2 to 13 and UHF 14 to 3) plus all FM/FM Stereo frequencies. This is the first ngle all-channel antenna using a single down-lead to chieve this performance break-through! (So advanced it ncludes VHF-UHF Splitter to provide separate lead-ins today's VHF, UHF, and FM stereo set terminals.) vailable in five gold alodized aluminum models.



MODEL	LIST
LPV-ZU20	$37.50
LPV-ZU10	17.95

Model LPV-ZU20 (deep fringe) shown

NEW! LOG-PERIODIC ZIG-A-LOG FOR "PROBLEM" UHF AREAS

This exotic all-new UHF series obsoletes bulky para- bolics and wind-prone stacked bowtie-reflectors. Packs more long-distance pick-up sensitivity per element. An- other ahead-of-the industry antenna advance that puts you in command of new UHF antenna business in your town. In two gold alodized aluminum models.

Model LPV-U9 (local and suburban) shown

MODEL	LIST
LPV-U21	$27.95
LPV-U15	18.95
LPV-U9	12.50
LPV-U5	6.95

NEW! LOG-PERIODIC LPV FOR UHF CHANNELS 14 T (PLUS VHF 7 TO 13)

Developed by the same team of scientists and engin that broke tradition with the JFD VHF Log-Periodic Delivers the high-gain, ghost-free signal needed in plex UHF for best channel 14 to 83 reception– channels 7 to 13. Available in four gold alodized aluminum rod, models—

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This powerful new marketing force will be at work building record Log- Periodic LPV Sales and Profits for you!

Correspondence

Univac I Not First Computer

Dear Editor:

I take exception to the paragraph on page 8 (News Briefs, "World's First Computer Becomes An Antique," February issue) stating that the Univac I was the world's first computer as of March 1951. I know from personal experience that this is completely incorrect, because I worked on the second computer, EDVAC, which was in the same building as the first one, the ENIAC, which I believe was used starting late 1945 to generate firing tables for the Army in the last days of World War II.

RAYMOND V. GORMAN
IBM Data Systems Div.
Kingston, N. Y.

[True. We should have known—back in May 1948, when we were called *Radio-Craft*, we had an article, "12,000-Tube Electron Brain," describing the IBM Selective Sequence Electronic Calculator.

Immediate source for the News Brief was a US Department of Commerce release titled "Census Bureau Retires First Computer." Possibly the headline misled us; very likely it should have read "Census Bureau Retires *Its* First Computer."—*Editor*]

Ultrasonics Stopped Readers

Dear Editor:

In the May issue of RADIO-ELECTRONICS, there was an article "Ultrasonics Stops Burglars" by John H. Fasal. I am very interested in getting more information about this system and would be grateful if you could give me the name and address of the company who manufactures the equipment.

JOHN CHMIELNICKI
Paterson, N. J.

[Write *Alarms Division, Walter Kidde & Co., Inc., Clifton, N. J.* We regret that all mention of the manufacturer's name in the article was inadvertently omitted.—*Editor*]

Fuse Resistance Changes with Temperature

Dear Editor:

The article entitled "Fuses—Are They Resistors?" by Frank G. Stiver in your December 1963 issue brought to mind an application I made of the resistance inherent in fuses.

The article presents resistance figures for fuses of various ratings. This, however, is somewhat imprecise. The resistance of a fuse is a function of the current flowing through it (actually the temperature of the fuse element) so that one must specify at what current the fuse resistance is measured. This property can be used to advantage in nonlinear feedback circuitry.

A few years ago I constructed an oscillator circuit which used a 5-ma fuse in an agc loop. One of the fuses I used had resistance values that varied from 265 ohms, at 0.5 ma to 495 ohms at 5.5 ma—almost a 2-to-1 variation.

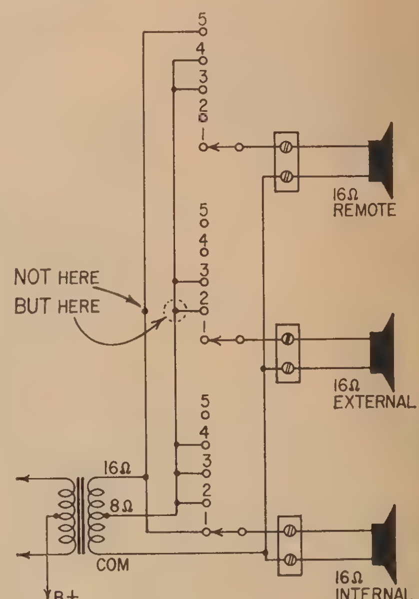
Undoubtedly, this variation of resistance could be used in many other applications, such as temperature-sensing and gain control schemes.

KENNETH WORKMAN
Tucson, Ariz.

Switched Switch Connections

Dear Editor:

There are two small errors in the "Speaker Switching Circuit" on page 95 of the March 1964 issue. When the switch is thrown into position 2, there is only one 16-ohm load on the 8-ohm tap of the transformer. In position 3, the EXTERNAL speaker remains on the 16-ohm tap, instead of being switched to 8 ohms.



I believe the circuit should look like the one in the diagram here.

SP5 HAROLD E. COTANT
APO 332, New York, N.Y.

Fips Fans, Unite!

Dear Editor:

When I received my first copy of RADIO-ELECTRONICS about a year ago, I had very little knowledge of electronics. Since then I have learned a lot, mostly because I have read your magazine. When there was something I did not understand, I asked others to explain and therefore I learned.

I've enjoyed very much the humorous articles by David W. Cramp and

119 INDEPENDENT SERVICEMEN ASSURED THEIR LIFE'S FUTURE with the LAFAYETTE ASSOCIATE STORE PROGRAM

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You're in business for yourself, probably an independent serviceman like those other 119 businessmen. You have a basic knowledge of radio, television or electronics, and most of all you have ambitions to become a true success story—with your own profitable business, a respected place in your community, and security for your family.

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5. Marketing Guidance—Our program helps you set up a complete operation. We'll help you select the right location, or evaluate your present one, design your store for maximum profit and assist in selecting your inventory. We'll show you how to deal with customers, how to hold a loyal following, how to build a successful business and maintain it. We will always be available to help you in any way possible. In short, we want you to be a Lafayette Success Story.

We are looking for a limited number of men who want to become part of America's largest and most successful Electronics Associate Store program, who are willing to invest $10,000 to $30,000 to make a new business career for themselves.

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Please send me full information on how I can own my own profitable business. I understand there is no obligation.

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Mohammed Ulysses Fips. (Why don't you start a fan club?)

I like your magazine so much that I am renewing my subscription for 3 years.

By the way: the two 12AU7's (three sections used) in Philip Stein's "Audio Sweep Generator (September 1963, page 28) can be replaced by a single 6AV11 triple-triode compactron.

JOSHUA LEVIN
Flushing, N.Y.

[Delighted to hear you enjoy RADIO-ELECTRONICS. (We do, too.) Actually, Mr. Fips has quite a large—though unofficial—fan club. Many readers we never hear from at any other time of year seem to stream out regularly to praise or criticize each annual offering. Is there a popular rally for Mr. Cramp's work, too?—*Editor*]

PC Boards for R-E Projects Still Available

Dear Editor:

We checked our stock and found that we still have a number of printed-circuit boards for these projects:

- Twin-Coupled Amplifier (November 1957)
- Flip-Top Radio (May 1961)
- 4-Channel Radio-Control (transmitter and receiver) (November 1961)
- Transistor Stereo Preamp (October 1962)

ARIEL STIEBEL
Detroit Electronic Corp.
13000 Capital Ave.
Oak Park, Mich.

"m" versus "M"

Dear Editor:

In a 1959 letter, not intended for publication, I referred to the unfortunate letter "m" which is badly overworked by being used as an abbreviation for many things and suggested its burden be reduced by using "Mc" for megacycle instead of "mc." The fundamental reason for this change is that *Mega* is a multiplier, and therefore the symbol representing it ought to be a capital letter. The second reason is that in Europe, the capital M has long been standard for *Mega.* By adopting Mc then, you might have been in the lead in the US.

From your detailed reply it emerged that for reasons of consistency R-E had adopted the "M" for mega *except* for megacycles, when "mc" was used.

I do not know if you are aware that the following year, the IRE in its *Proceedings*, September 1960, page 1539, published its official decision to adopt "Mc" for megacycle.

With "Mc" thus becoming the official US symbol, it would seem that R-E's continued use of "mc" is an example of "everybody being out of step but our Johnny."

I see from page 43 of the February '64 issue re "p" for pica that you are flexible and do adopt modern abbreviations sometimes. Do please therefore review the earlier suggestion. Incidentally, some of your readers may not be aware that the picofarad, long a friend of technicians in Britain, has a pet name. It is "puf".

While on the subject, what about Kc for *Kilocycle?* That would make all the multipliers capital letters and even justify being out of step with the rest. Perhaps your readers would like to comment on this last item.

P. G. A. H. VOIGT
Ottawa, Canada

[Mr. Voigt will be happy to learn that the US Bureau of Standards has adopted the International System of Units and will employ it in all its publications "except where use of these units would impair communication . . ."

Incidentally, among terms adopted by the Bureau of Standard is the hertz (abbreviated Hz), for cycles per second. So the discusson on "Mc" *vs* "mc" may become academic in the near future.—*Editor*]

Criticizes Test CRT Story

Dear Editor:

Please send Art Margolis down to the bottom of the class for his test CRT article ("Ease Service and Sales with a Test CRT," January '64, page 32). Surely the first thing to do for a dark picture, as in his 16-inch G-E, is to check CRT base voltages. His outside man should have cleared the CRT even if he couldn't find the fault.

It doesn't just take 3 minutes to fit the test CRT; the set has to be brought in from the house and taken back. Judging by the incompetence of his outside man, the trouble could well have been a broken lead to the CRT screen.

Don't capacitors have resistance? I always thought they had lots of it—megohms, in fact—and that the only things without resistance are bits of wire.

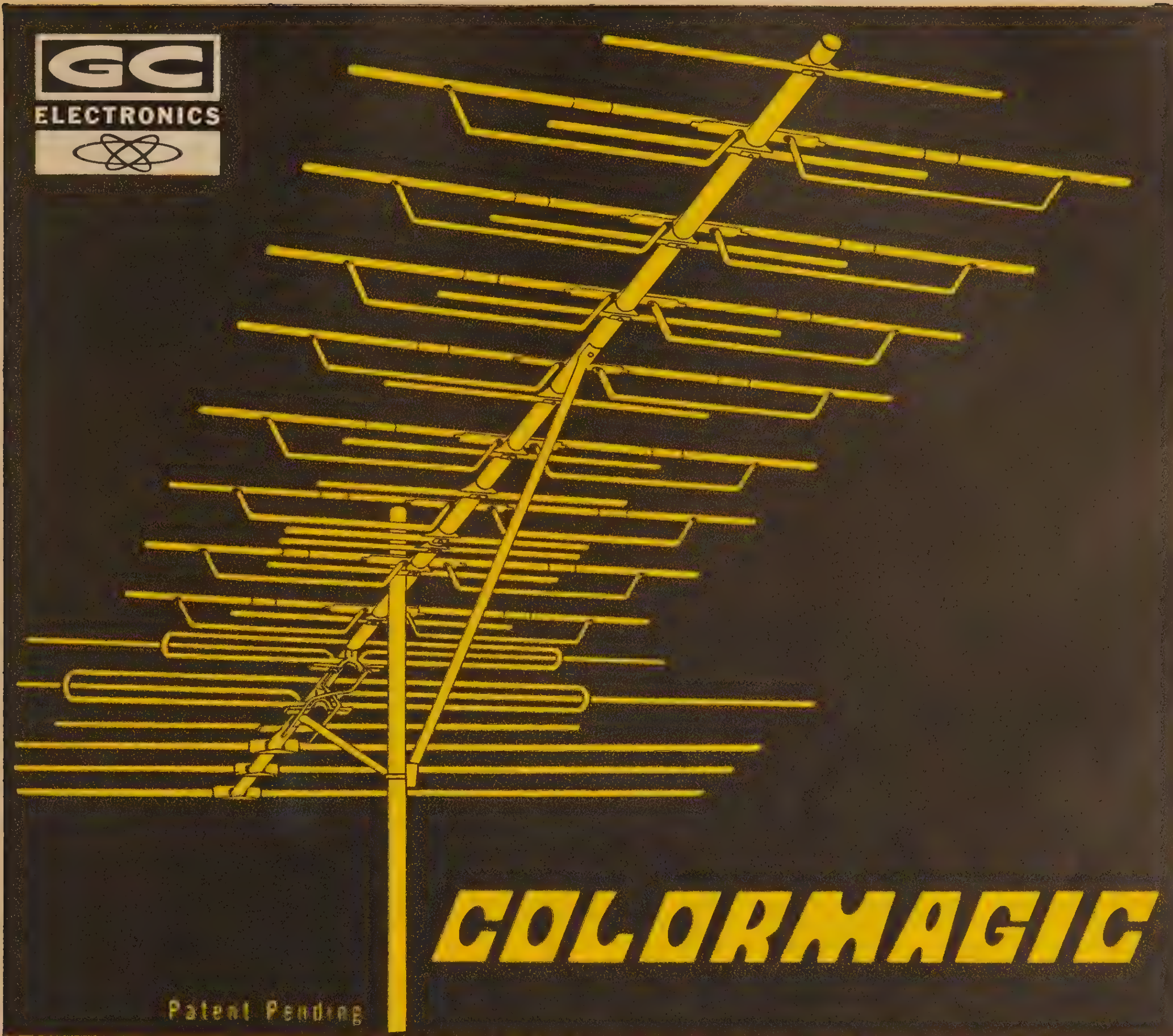
P. M. LEYDEN
Nottingham, England

Art Margolis replies

The first thing we do for a dark picture tube is not to check for CRT base voltages. We check cathode emission. In most cases voltages are not at fault — lowered emission is. Incorrect CRT voltages are rare. Rare TV diseases. because of their very rarity, cause an occasional incorrect diagnosis. Perhaps your skill in diagnosis would have precluded the error. At any rate, in that case, we did err at first glance. That's the way it goes.

On our bench, which is where the episodes in the article took place, fitting the test CRT *doesn't* take any longer than 3 minutes in most cases.

A fast practical test of leakage in a capacitor is its resistance. On a vtvm, a good capacitor will read infinite. Any reading even in the megohm range means leakage and indicates replacement. END

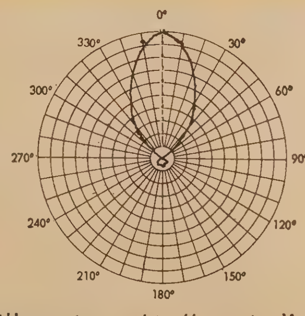


FHR **FUNDAMENTAL HARMONIC RESONANCE...GC'S EXCLUSIVE DESIGN PROCESS!** Colormagic elements resonate on the fundamental harmonics within both the high and low bands. Colormagic FHR outperforms the average second harmonic TV element by producing a tight, laser-linked directivity of signal...higher gain! It's in the elements!

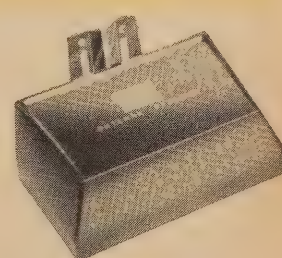
GC "GOLD-GUARD" anodizing process guards against pitting, chipping, rust and corrosion...makes the Colormagic series the best protected, all-weather line available!

GC "SOLID-SEMBLED" construction insures quick, easy installation...rigid-lock elements snap securely into place!

Compare! Colormagic Antenna Systems offer pencil-point polar patterns...laser-linked directivity ...flat plateau response curve... no traps or peaks...excellent for color or black & white TV reception.



15 All-New Colormagic Combo-Couplers permit cross-direction reception of UHF-VHF-FM antenna combinations...each unit encased in high-impact polystyrene case...supplied with stainless Steel mounting strap. Complete sales program available.



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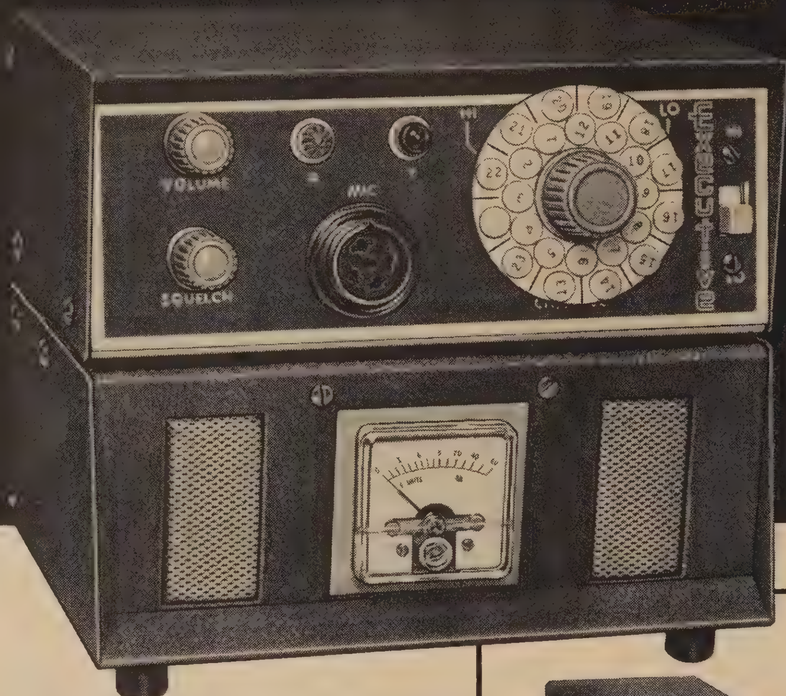
INTERNATIONAL'S NEW EXECUTIVE 750-H CITIZENS BAND TRANSCEIVER . . . FOR PEOPLE WHO EXPECT THE VERY BEST*



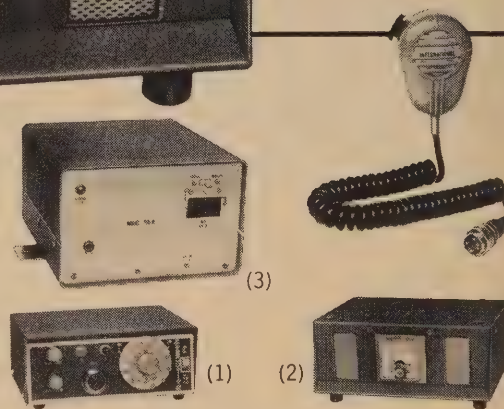
The International **Executive 750-H** introduces a transceiver that is quickly adaptable to all types of mobile or base installations.

The remote console, which is normally installed under the auto dash, has a new companion speaker console. It may be combined with the remote unit or mounted separately. The speaker makes a perfect base when the remote console is used on a desk. Provision has also been made for adding an S/meter.**

What's more, the Executive 750-H is loaded with extra performance features; such as, 23-crystal controlled channels, illuminated channel selector dial, a new speech clipper, increased selectivity, new connections for easy cabling.

The Executive 750-H is complete with crystals, mounting rack for the remote console, trunk mounting rack for the set, push-to-talk microphone, power cable kit, plus all necessary connecting cables. Operates on 6 vdc, 12 vdc, or 115 vac.

Your International dealer has a liberal trade-in plan. **Step up to an Executive 750-H today!**



The Executive 750-H consists of three units: (1) the remote console, which turns the set (in the trunk) on or off, adjusts speaker volume and squelch; (2) the speaker console; (3) the main set which houses all other transmitting and receiving components.

*Performance—Construction—Design—Components
**S/meter available as an accessory item.

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...What It Is For—What It Will Do...

WE RECENTLY had the privilege of visiting the *Arecibo Ionospheric Observatory* (its official name), the giant radio telescope that we pictured on our Feb. 1964 cover and described in technical detail in the article on page 36 of that issue.

Because of its stupendous vastness, its even greater technical complexity, and because of its potentialities as a key for unlocking much of our still unknown universe—almost universally uncomprehended—we should like to say a little more (in simple language) about its *raison d'être*.

Like the great pyramid of Cheops, whose real purpose was unknown and for thousands of years understood by only a small minority (it was to be the Pharaoh's tomb), the Arecibo Observatory and its purpose is a dark secret for most of the American population. Few have heard about it. Even in Puerto Rico it is a total enigma. It is vaguely known as "a big radar." No one, even among the most intelligent people, knows that the observatory is really the biggest single thing in all of Puerto Rico.

Located 12 miles south of Arecibo in the north of Puerto Rico, some 62 miles from San Juan, the observatory is in an almost perfect wilderness in the hills. It was the brainchild of Professor William E. Gordon of Cornell University who was appointed director of the facility.

Erected at a cost of almost 9 million dollars, the Arecibo Ionospheric Observatory (AIO) was constructed over a period of almost 4 years, under contract with Air Force Cambridge Research Laboratories by Cornell University and the US Army Corps of Engineers.

Its chief physical feature is its 1,500-foot diameter bowl, blasted out of the rock, in a natural depression. It is a spherical cap—not quite a half sphere. It required the removal of 300,000 cubic yards of rock and earth to fashion the bowl in the valley. The lower part of the bowl is completely lined with heavy, mesh wire on metal cables. Total dish surface is about 18.5 acres.

Figures or even photographs mean little in helping us visualize the huge size of this bowl that could hold 403,000 humans standing upright, without undue crowding. Suspended high over the center of the bowl is the 500-ton triangular "feed system" measuring 200 feet on a side. It has a 340-foot crescent-shaped arm which can be rotated horizontally over the bowl. Attached to the arm is a 96-foot "line feed" pointing down to the bowl and positioned 435 feet over it. Its purpose is to steer and reflect incoming as well as outgoing radio waves.

The rôle of the Observatory is threefold.

1. It will vastly increase our knowledge of the earth's ionosphere, which can be called "the curved electronic mirror in the sky." Composed of electrically conducting ionized gas, it envelops the earth from a distance of 200 miles out to a distance of several thousand miles. Without the ionosphere, much of our broadcasting and radio communication would not be possible.

The Department of Defense believes that better knowledge of our ionosphere would greatly assist it in tracking enemy I.C.B.M.'s.

2. The Observatory's future rôle of listening in to distant star electronic emissions is vitally important to Radio Astronomy research. Only very recently (1964) have scientists listened in to radio star emissions that originated *10 billion years ago!* This knowledge helps us to interpret the age of the universe.

3. A.I.O. now makes it possible to beam more powerful radio and radar signals to the various planets of the solar system with greater precision.

The Observatory can beam the world's strongest radar signals into space—2½ million watts at peak power. Since A.I.O. opened last November, its scientists have sought to contact the solar system's largest planet, the giant Jupiter 400 million miles distant. So far, however, the experiment has been inconclusive, probably because of that planet's deep, gaseous envelope that could have absorbed the radar energy completely. No reflected signals from Jupiter could be detected at A.I.O. This in no way discourages associate director Dr. G. H. Pettengill, who is an old hand at reflecting radar beams successfully from planets. He was among the first to bounce radio emissions from Venus, when he still was connected with MIT's Millstone Hill radar installation. ("Road to Universe opened", RADIO-ELECTRONICS, May 1959, page 47.)

Dr. Pettengill will try again with the giant Jupiter this Fall, using either different radio frequencies or different waveforms, and new ways of processing the returned signals.

Right now, Pettengill and his associates must solve one of the most important and pressing space problems: *What is the actual consistency of the lunar surface?* Late in March, Moscow scientists declared that the moon is deeply covered with meteoric dust, making any landing by humans extra-hazardous. This has been predicted by a number of scientists as well as the present writer for many years.

Pettengill expects that much new information about the lunar surface consistency can be obtained with the A.I.O. radar sometime in the near future. If a deep quicksand-like dust layer actually exists, the NASA scientists who are building the lunar space capsule must alter their design, so that the capsule with its human explorers will not sink out of sight into a sea of impalpable dust.

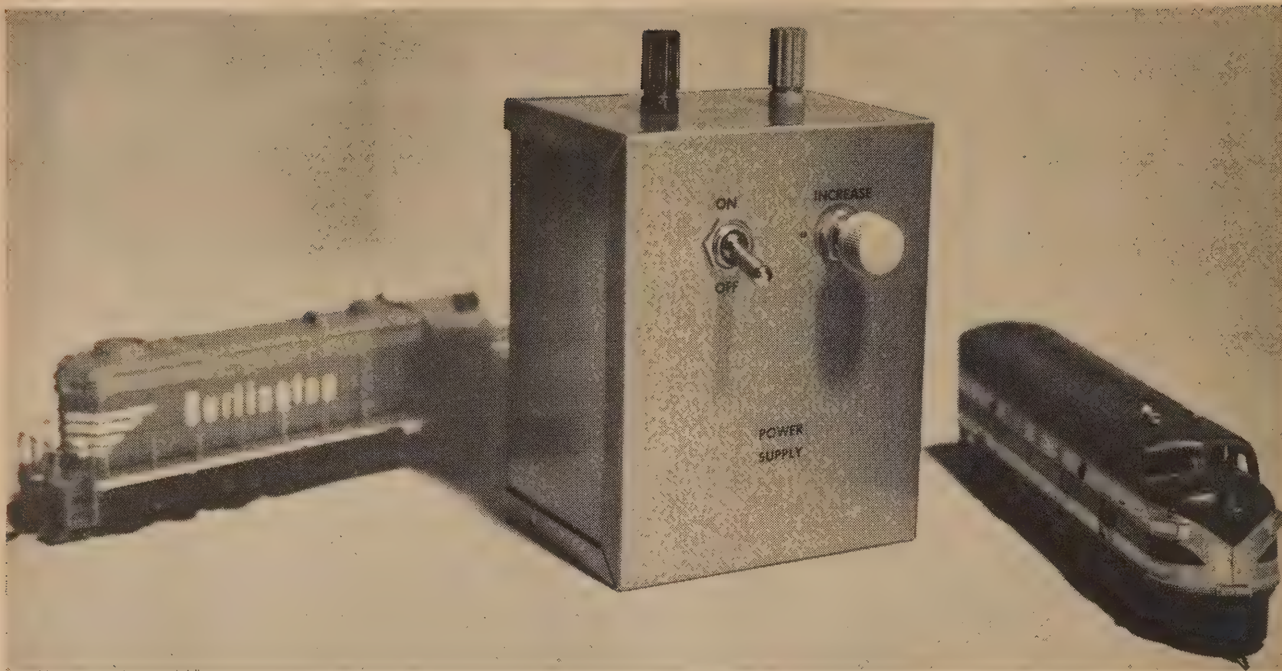
How does one "listen in" to the world's "biggest ear"?

It was K. Jansky, who in Dec. 1931 was the first to discover that radio waves were reaching the earth from some source in space. This in time became the present art of Radio Astronomy, or listening in on the radio emissions of distant stars. Jansky listened in with the usual earphones, because that was the only means we had to hear the distant radio noises in those days.

Nowadays all this has been changed radically. Humans no longer "listen in" directly with their ears to distant stars. At A.I.O. modern data processing equipment now does the task of humans. Here the latest computers with their associated oscilloscopes and accurate time recorders are used.

The equipment records all signals automatically, filtering out unwanted noises. Then the equipment records all signals as well as the exact time on special typewriters.

Inasmuch as the computers can work around the clock, the scientists are free to do other essential work—or sleep. All "listening in" is done automatically by the computers. Next day, or later, the scientists read the recorded data and interpret the results—a long and painstaking job. —*H.G.*



The versatile semiconductor version of a thyratron makes simple battery charger, slave photoflash, model train control

SCR Basics For Experimenters

By CARL HENRY

ALTHOUGH SILICON CONTROLLED RECTIFIERS have been available for some time, their high price has discouraged experimenters. Now that prices are dropping, single units are available for as little as $3. Considering the marvelous properties of the silicon controlled rectifier, this opens a whole new field for electronic experimenters.

The first of the practical circuits in this article is a light trigger circuit to convert either electronic or standard flashguns to slave operation. The SCR has a high voltage breakdown, and so can be used where more than 200 volts is applied across it, as in this trigger circuit. Few transistors will work here, and those that will are expensive. Once turned on, the internal resistance of the SCR is low enough to fire the flash circuit (or standard flash bulbs) in a time so short that, for normal photography, it is not worth considering.

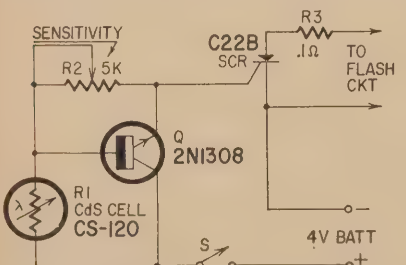


Fig. 1—Circuit of photoflash slave. R2 can be replaced by suitable fixed resistor if slave is to be used with a particular flash unit.

The circuit (Fig. 1) is based on the variable resistance of a cadmium sulfide cell. When a burst of light causes a sudden decrease in the resistance of R1, transistor Q is triggered on. This sends a current through the SCR gate circuit. The SCR conducts and fires the flash circuit. Note that the transistor (an n-p-n type) is direct-coupled by its emitter to the gate of the SCR. This type of coupling is necessary because of the low input impedance of the SCR gate circuit.

This circuit illustrates the use of the SCR as a static switch. That is, in any circuit where a switch is used, an SCR can replace it. However, this is true only for those circuits where the switching action of the SCR, once in operation, causes the voltage to drop below the value required to maintain a holding current action, and resets the SCR. Otherwise the SCR will turn on but not turn off. (Like a thyratron.)

Resistor R3 is a surge limiting resistor. If you experiment, be sure to use such resistors, and use diodes to protect the SCR where possible. I find that even very short transients can be damaging if the SCR is not protected. Use a diode in the gate circuit to prevent a reverse voltage from being applied to the gate, wherever possible. Two diodes back-to-back across the line will prevent line transients from ruining the SCR. So-called "contact protectors" work well in these protective applications.

Fig. 2 illustrates a second type of SCR circuit. Here the amount of current passed by the SCR controls the speed of a drill motor or the heat of a soldering iron. Just the ticket for slowing down that electric drill to prevent softening plastics, or to lower the heat in your soldering iron when working on delicate circuit boards. The basic circuit was originally developed by General Electric. One of its features is that it provides constant torque when used with a drill motor. Excessive use of a motor at low

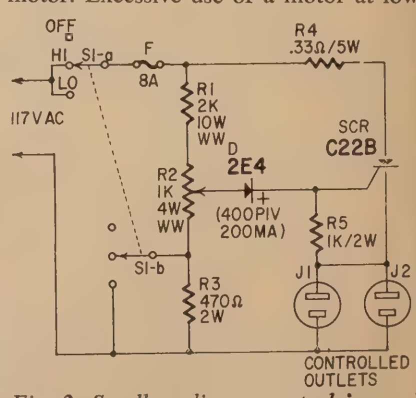


Fig. 2—Small-appliance control is good for drills, mixers, sewing machine motors or light soldering iron.

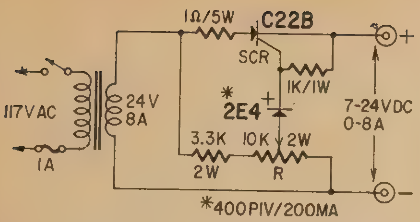


Fig. 3—This circuit can be used as battery charger or for light electroplating work.

speeds is not a good idea, since the motor may overheat.

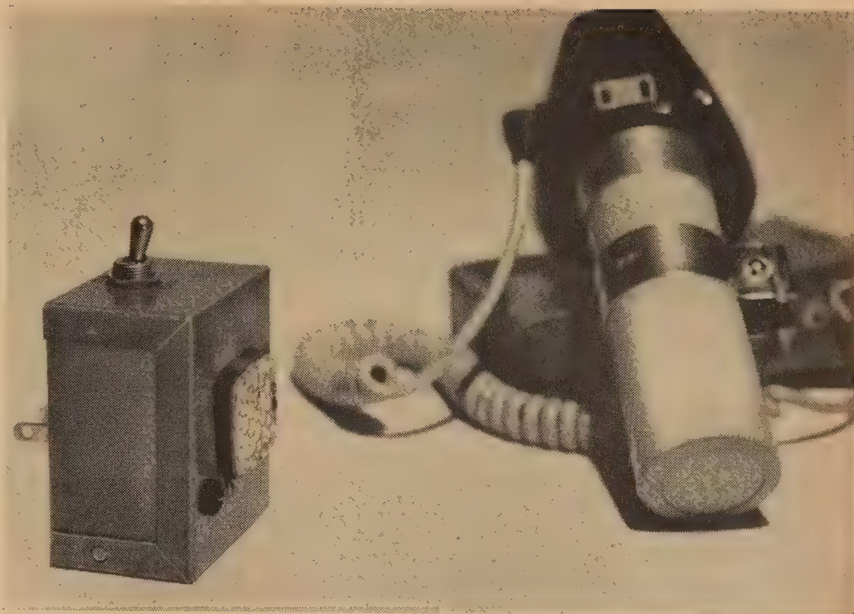
The circuit basically is of the phase-control type, very similar to the older thyratron circuit. The gate circuit of the SCR is supplied with the positive half of the ac input, the negative half being blocked by diode D to protect the SCR gate from reverse voltage. As this positive voltage increases to some value determined by the setting of S1 and R2, sufficient voltage is applied to the gate to turn on the SCR. The SCR is turned on for some portion of the positive half-cycle, and supplies pulsating dc to the load.

Switch S1 selects either a HI or LO speed function, and R3 is switched in or out, determining how late in the half-cycle the gate firing can be set. With R3 out of the circuit, gate firing can be completely prevented by setting R2 to its minimum position. The controlled device is plugged into either J1 or J2.

The maximum load is of course determined by the rating of the SCR. Here a G-E type C22B was used, for which a maximum load of 880 watts is recommended. This SCR is a press-fit type, the case being the anode connection. I mounted the SCR on a small block of aluminum, and mounted the block on standoff insulators. I installed two receptacles, since I intended to use the unit as a lamp dimmer. It works very well, by the way, and control two small spotlights to any degree of brightness or dimness desired. Remember not to exceed the maximum load rating of the SCR when using large photofloods.

Don't be misled into thinking that a simple zero-to-maximum control is possible with SCR's in dc circuits. The schematic of Fig. 3 is the third practical circuit. It demonstrates that complete control, as in the case of thyratrons, transistors and vacuum tubes, is not possible with a simple SCR circuit. A simple battery charging circuit, it again relies on phase control. The output current, not the voltage, is varied by R. This will mean that a voltmeter on the output, or any high-impedance low-current device, will indicate either a voltage or no-voltage condition. With heavy loads, such as battery charging, however, the output current can be varied from a maximum of 8 to a minimum of 1 amp.

Fig. 3 makes a nice simple charger circuit, and considering the number of parts and the amount of control possible, it works well. This circuit was constructed in a Bud Minibox, and then modified into the next circuit I am going to discuss.



SCR photoflash slave diagrammed in Fig. 1.

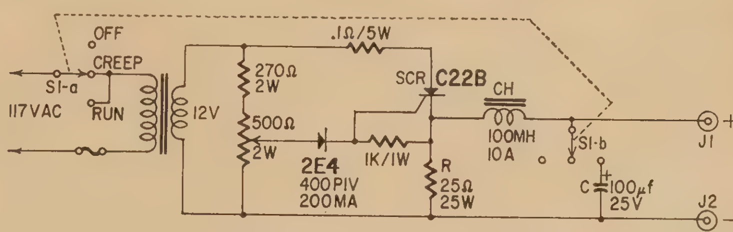


Fig. 4—Model train control. Choke CH should have as much inductance as possible. It can be replaced with a 1-ohm resistor. C1 can be switched in or out, to give smooth dc or high-ripple dc for more even speed control.

Figs. 4 and 5 show the low-voltage supply modified to operate HO model trains. The SCR is a natural for this field. In fact, General Electric has announced their Astrac model train control system, a unique and interesting application of the SCR. In the Astrac system, each model engine to be controlled is equipped with a small module containing two silicon controlled rectifiers. Each has a tuned circuit in its gate lead. The track is fed with ac instead of the conventional dc. A transistor oscillator supplies the keying signal, superimposed on the ac track voltage, to the particular engine you wish to operate. As many as five engines may be operated at the same time at five different speeds. When each engine receives the proper signal, determined by the resonant circuit in its gate lead, the SCR in the engine is turned on, and the engine motor receives pulsating dc power from the track. Engines can be reversed by supplying a second frequency to the other SCR on the engine module, which in turn supplies a reverse voltage to the engine motor.

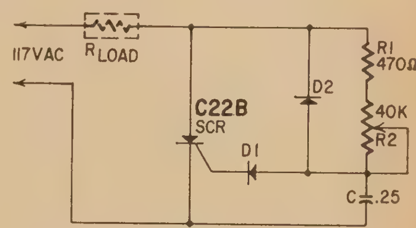
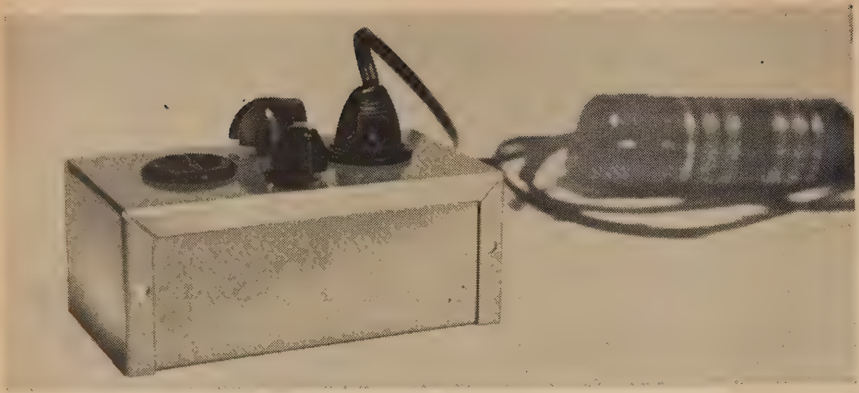


Fig. 5—G-E-developed control for use at 117 volts ac or at 12 or 24 volts ac for model train control.

Although it doesn't have the advantages of the G-E Astrac, the circuit of Fig. 4 has several desirable features for the model enthusiast. The direct phase control can be used as shown, or the circuit of Fig. 5 can be substituted. A 12-volt filament transformer is used in the circuit of Fig. 4, and an auxiliary outlet can be provided for lamps or other HO accessories. The 25-ohm loading resistor R is necessary for good regulation and proper operation. Otherwise, control action at low voltages is not smooth.

Note that a choke input filter is used. It can be replaced with a resistor to reduce the size of the unit, but gives better control and regulation. Do not use a capacitor directly on the output of the SCR. If the capacitor is large, it will have a flywheel effect, and changing the gate firing time will not vary the



Small-appliance control of Fig. 2, built into aluminum box.

output voltage.

For creeping and slow operation of model engines, pulsating dc works better than filtered dc. For this reason, C is removable from the circuit. The output is variable from 2 volts to 12. Fig. 5, a control circuit worked out by G-E engineers, offers better control than the simple phase-control circuit shown in Fig. 4. On the positive half-cycle of SCR anode voltage, the capacitor charges to the firing point of the SCR in a time determined by the time constant (R1 + R2)C, and the increasing anode voltage. On the negative half-cycle, D1 blocks the gate circuit while D2 resets the capacitor for the next charging operation. Two of these circuits, paralleled back-to-back and with the potentiometers tracking and ganged, will give complete control of the entire ac cycle.

If you do much work with SCR circuits, you will probably want to use the circuit of Fig. 6 for testing the SCR's themselves. It is difficult to test an SCR with an ohmmeter, since some method must be provided to turn it on, and a holding current must be maintained. In Fig. 6, the job is done like this: Battery BATT1 supplies the main SCR current, with provision being made for reverse testing. Lamp 1 indicates by its brightness the amount of anode current, and lamp 2 any reverse current. Normally lamp 2 should never burn; if it does, the SCR is defective.

Resistor R1 and switch S2 check the holding current feature of the SCR. It may be necessary to select different values of resistance, depending on whether high-, medium- or low-power SCR's are to be tested. Battery BATT2 and resistor R3 provide a variable gate current, while lamp 3 indicates its intensity.

To test an SCR, first connect it to terminal posts J1, J2 and J3. Set S1 to REVERSE, and observe any leakage on lamp 2. Then set S1 to NORMAL with R3 at minimum. R3 can be calibrated in terms of current. Advance R3 until lamp 1 indicates current flow in the SCR, noting the gate current flow at the same time. Check the manufacturer's specifications for the SCR under test to see if the triggering point lies within the proper range. The holding current is checked by operating S2 and noting whether the SCR continues to conduct when the switch is released. Check the maker's specifications for the minimum value of holding current. Resistor R1 can be made variable, and calibrated in terms of holding current if a more accurate check is desired.

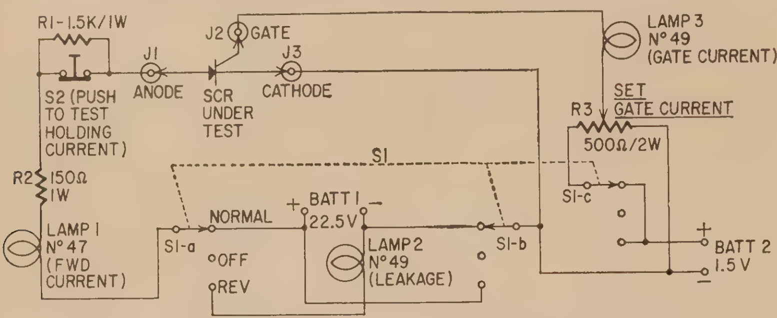


Fig. 6—Simple SCR test circuit gives qualitative check on performance. Defective units show up immediately.

I believe you will find this simple checker much more conclusive than an ohmmeter, and much easier to use.

[Though not listed in the main 1964 catalog, the G-E C22B is stocked by Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill., along with other SCRs in the line. They are listed in a recent supplement. Newark Electronics Corp., 223 W. Madison St., Chicago 6, also carries the complete G-E line, listed on page 65 of the 1964 catalog No. 75.—*Editor*] END

"FLASH OF GENIUS"

AN URGENT CALL ABOUT AN HOUR BEFORE the big game sent me flying to a suburban customer's set.

"You know what they'll do if you can't fix it," taunted the boss, as I dashed out. "If they miss the game, they'll eat you alive."

This place on the edge of nowhere takes 45 minutes to get to. With 12 minutes to go, I see the raster fold up as the 25DQ6 plate's "cherries," Smugly I reach for the oscillator tube. A new tube restores the raster, but it fizzles away as I tighten the last screw on the back. Horrified, with 7 minutes to kickoff, I yank off the back. Out flies the horizontal output tube and I fumble around for a new one. Five minutes left and there's none in the tube caddy!

The little group of football fans have grown hairy claws and have long fangs now. Suddenly, from the blue, a flash of genius makes me pull the plug of the little TV lamp on the top of the set and shout, "Bring me light bulbs, quick!"

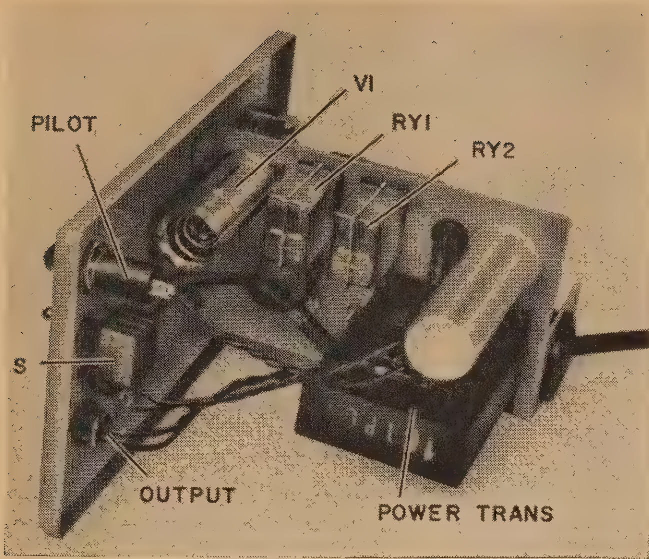
Two ghouls fly off and return with 15-, 60- and 150-watt bulbs. Two minutes, 30 seconds. Off pops the shade, out comes the little bulb and in goes the 150-watt lamp. I put the TV lamp on the set and bend the plug fins to fit across the fuse holder. I pull out the line fuse, the plug takes its place, and I flick on the set. A bright glow dims out as the doubler charges, and the lamp glow slowly brightens as the tubes warm and begin to draw current.

The raster returns, a bit narrow, but clear and bright as the sound roars in. There's the kickoff!

I stand holding my breath for 2 whole minutes, waiting for the raster to fade along with my hopes of returning to the shop alive. It stays.

In fact it stays until next Monday when I return to a happy customer who thinks I'm a magician.

How'd I do it? Simple. The shrinking raster told me that the oscillator didn't quit all at once, and the "cherry" plate spoke for the power supply and screen resistor. The tube was gassy and failed after secondary emission nailed the grid down and chased the plate current up as high as it could go. I concluded (my dear Watson) that this occurred after the tube reached a critical temperature, because the raster did appear at first, then died away. The lamp across the fuse holder reduced the input voltage, dropping plate and heater voltages and reducing the tube temperature below the runaway point.—*Steve P. Dow*



In author's version, chassis is bent up from sheet metal and mounted vertically. A more compact layout should be practical.

electronic slide changer

Used with a solenoid-actuated projector, this device brings on the next slide—IF you stop talking long enough!

By WALTER G. LANDRIEU

VARIOUS SCHEMES HAVE BEEN DEVELoped to synchronize a slide or film-strip projector with commentary recorded on a tape recorder. Most use low- or high-frequency tones or a photoelectric circuit to control the changer. But this device needs no such extras.

This system uses the *silent* period between commentaries to operate the slide-change solenoid or relay. When the silent period exceeds a preset limit, say 4 seconds, the switching circuit operates automatically.

The circuit of my slide actuator is shown. The slide mechanism is tripped by momentarily closing the control loop between terminals A and B. V1-a is an audio amplifier that is fed a signal of at least 1 volt rms tapped off the recorder's voice coil or line output. V1-b is the relay control tube. It is set up so RY1 is energized when there is no audio signal at the input jack.

V1-a's input circuit is set up so the grid can become only slightly more positive than the cathode. (The grid–cathode circuit acts as a diode that conducts on positive half-cycles. Neglecting the internal grid–cathode resistance during conduction, the grid and cathode are at the same potential and plate voltage is constant during the positive half-cycle).

How it works

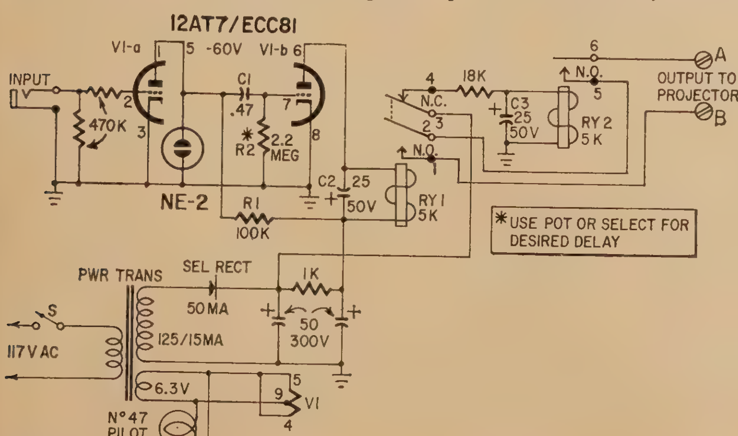
When a signal is being supplied by the recorder, V1-a's grid follows negative swings and V1-b's average plate current drops to the point where RY1 drops out (releases), opening contacts 1–2 and closing 3–4. RY2's coil is energized through 3–4 and its contact (5–6) closes. The control loop is held open by 1–2.

When a silent period occurs, C1 begins to discharge through R1 and R2. A large negative voltage develops across R2 and cuts off V1-b for a period of time determined by the values of C1 and R2.

When the silent period exceeds the predetermined limit, C1 has discharged to the point where V1-b begins to conduct and re-energizes RY1. Although this breaks RY2's supply circuit, this relay does not release until C3 has discharged through its coil. Now, the control loop is closed through 1–2 and 5–6 and the slide-change solenoid is energized. (The duration of the energizing pulse is determined by C3's capacitance and RY2's coil resistance.) The circuit returns to its original state when RY2 opens.

Do not omit the neon lamp. It clamps V1-a's plate voltage, so strong input signals cannot drive V1-b hard enough to energize RY1 and trigger the unit erratically.

The control unit, called the Silentact, is built into a small metal box. Relays, tube, power transformer and filter capacitor are above the chassis. The remaining components are below (see photos). The relays—European types—pull in at around 4 ma and release at 1. Comparable American types can be used. END



Sole "operating control" on front panel is on–off switch. Operation is completely automatic.

Servicing FM Stereo Circuits

Need expensive equipment? No! You can use a stereo station as a signal source

By LEONARD FELDMAN

FM stereo transmitter of New York City's WQXR-FM. Like other multiplex FM transmitters, it is a source of precise 19-kc signal for tests.

MORE AND MORE ELECTRONIC TECHNICIANS are being called on to service and align FM stereo multiplex circuits as the popularity of FM stereo broadcasting grows. The service technician has been reluctant to purchase the expensive ($275 and up!) multiplex generators which, he has been led to believe, are necessary for proper multiplex servicing and testing. As a result, many technicians have turned away customers.

The fact is that *nearly every trouble in multiplex circuitry* can be analyzed and corrected by using the very finest multiplex generating equipment available free of charge—the FM stereo transmitter! Checked out by the FCC, the FM stereo broadcast station transmits a crystal-controlled 19-kc pilot signal as well as the composite audio signal consisting of main channel—left plus right (L + R), and subchannel—left minus right (L − R)—sidebands. These two elements of transmission can be used to service and align multiplex adapters or the multiplex section of FM stereo receivers. All you need is a good FM tuner. It doesn't even have to be equipped for stereo reception. Simply tap off, with low-capacitance shielded cable, at the output of the ratio detector or discriminator (Fig. 1). Be sure the cable is connected *before* any high-frequency de-emphasis components.

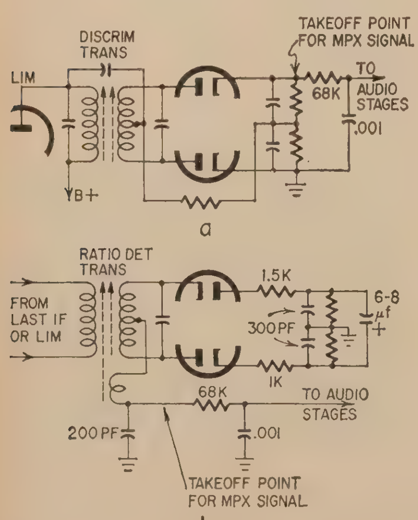


Fig. 1—Discriminator detector, and (b) ratio detector. Takeoff points for composite audio must be before de-emphasis networks, as shown here.

Your "tuner–generator" should be equipped with an outdoor antenna, so that the composite stereo signal recovered will be as free of noise and as strong as possible. For problems involving loss of separation, distortion, etc., the composite signal thus obtained can be used directly. For oscillator alignment, subcarrier restoration or anything having to do with self-contained 38-kc subcarrier circuits, it will be necessary to construct a small one-tube 19-kc amplifier (Fig. 2). This circuit will amplify the crystal-controlled 19-kc signal from the station and will isolate this signal from the rest of the audio composite signal. It provides a stable, accurate source of variable-amplitude 19-kc signal. Attempts to use your bench audio oscillator for this signal source would be doomed to failure, since the frequency needs to be within 1 cycle of 19 kc and must not drift or even change phase.

Types of multiplex circuits

FM stereo circuits may be classified in two broad categories: matrix types and switching types. Fig. 3 is a block diagram of the matrix variety. A typical switching-circuit block diagram is shown in Fig. 4. Matrix circuits, popular when stereo FM first came upon the scene, have largely been abandoned in favor of the simpler switching circuits, which require fewer, less accurate filter components and are therefore less expensive to manufacture.

Whether you are servicing a matrix or a switching circuit, a large-amplitude 38-kc signal is needed at the input to the demodulating diodes. In most circuits, the rms value of the 38-kc voltage will be 5 volts or more. This may be made available in one of two ways: either the circuit contains a local oscillator (oscillating at 19 kc and subsequently doubled to 38 kc, or oscillating directly at 38 kc) which is synchronized with the incoming 19-kc pilot signal from the station, or the 19-kc pilot itself

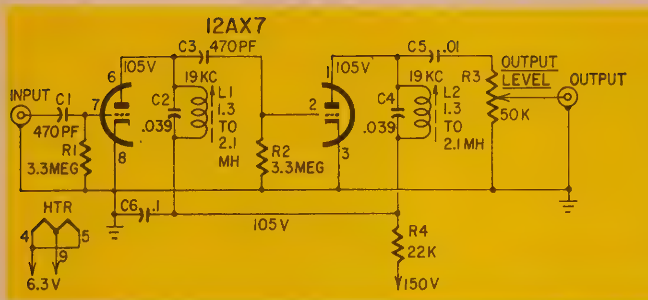


Fig. 2—Simple two-stage 19-kc amplifier connected to any FM tuner tuned to stereo station provides low-cost source of exact 19-kc pilot tone.

C1, C3—470 pf, mica or ceramic
C2, C4—.039 µf, paper, mylar, ceramic
C5—.01 µf
C6—.1 µf
L1, L2—slug-tuned coil, 1.3–2.1 mh (Miller 4414 or equivalent; Allied stock No. 60 G 994, $1.97 plus postage)
R1, R2—3.3 megohms, ½ watt
R3—pot, 50,000 ohms, linear
R4—22,000 ohms, ½ watt
12AX7 tube
Phono jacks (2)
9-pin miniature socket
Aluminum Minibox, 3¼ x 2⅛ x 1⅝ inches (Bud 3001A or equivalent)
Miscellaneous hardware

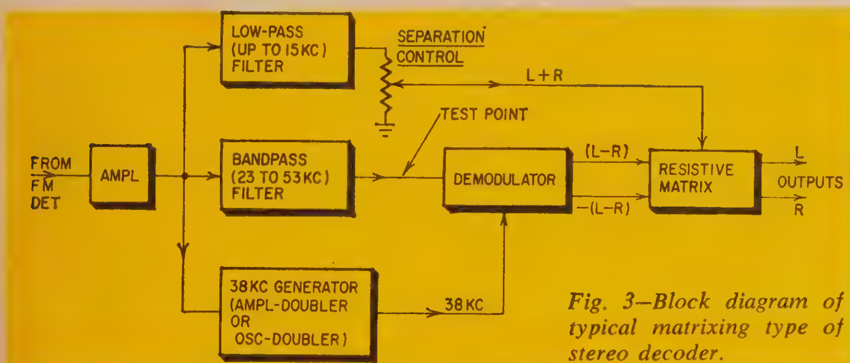


Fig. 3—Block diagram of typical matrixing type of stereo decoder.

can be stripped away from the rest of the composite signal (much as was done for the test jig of Fig. 2), amplified and doubled without any built-in local oscillator.

Absence of this 38-kc signal, or its presence in reduced amplitude, will result in extremely distorted output and no separation of left and right channels. In circuits having a local oscillator, it is easy enough to determine whether the oscillator is functioning merely by observing the waveform at the grid or plate of the oscillator stage. If it is oscillating, you will see a clean sine wave.

Once oscillation has been established, this sine wave can be observed all the way along through amplifiers and doublers, right up to the demodulation circuit, where the waveform will appear as in Fig. 5. The inequality of adjacent sine waves indicates the presence of some 19-kc components resulting from imperfect doubling. This component will not seriously affect performance and can be ignored.

In circuits not having local oscillators (and hence dependent on the incoming 19-kc signal to create the large-amplitude 38-kc carrier needed for detection), signal tracing is similar, except that the 19-kc amplifier of Fig. 2 will be required. Apply a signal of about 0.1 volt rms to the input of the multiplex circuitry and trace its progress through the 19-kc and 38-kc amplifiers and doublers, all the way up to the demodulating diodes. If all is well with these stages, at least 3 to 5 volts of 38-kc voltage will appear at the head end of each of the demodulating diodes.

A good check to perform on this circuit is to vary the amplitude of the 19-kc input signal with the potentiometer shown in Fig. 2. (It is understood, of course, that the 19-kc amplifier test fixture must be hooked up to a tuner tuned to stereo when these tests are made.) Check for a 19-kc signal at the output of the test fixture before assuming that the multiplex circuitry itself is at fault. As the potentiometer is varied to provide an output greater than 0.1 volt, there should be no significant increase in 38-kc voltage at the demodulating diodes. Further, as the 19-kc input is decreased, no significant decrease in 38-kc voltage should result until the 19-kc input is attenuated considerably. This test proves that all tuned circuits are peaked up to their maximum, and that the 38-kc voltage at the demodulators is stable and adequate for the job.

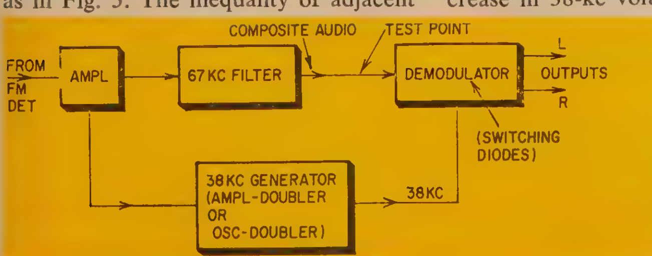


Fig. 4 — Typical switching multiplex circuit looks like this. Only one filter is required.

Unsynchronized oscillators

Referring again to circuits containing their own local oscillators, the test fixture of Fig. 2 is most useful in tracing loss-of-synchronization problems. The mere presence of large-amplitude, 38-kc signals at the detectors of such a circuit does not insure proper performance or stereo separation. If, on applying a 0.1-volt rms 19-kc signal from the test fixture to the circuit, you hear a low-frequency motorboating sound, the self-generated oscillations are not being synchronized by the incoming pilot signal. Assuming that there are no faulty components in the path from the input to the point where the sync voltage is applied to the local oscillator, the cure is a simple touchup of the oscillator alignment, which will be dealt with shortly.

To determine positively that synchronizing voltage is getting all the way to the oscillator, disable the oscillator itself by removing the tube. This will prevent mistaking the oscillation itself for the incoming synchronizing voltage. If the tube is a multipurpose type, such as a dual triode, the oscillator is best disabled by connecting a very large capacitor (such as a 1-μf electrolytic of high enough voltage rating) from the plate of the oscillator section to ground.

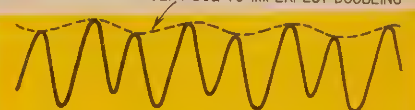
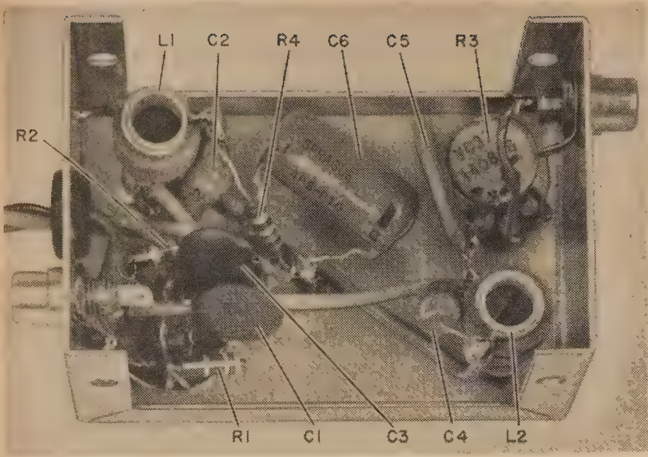


Fig. 5—38-kc voltage at input to demodulating diodes may look like this. Residual 19-kc signal is common and usually harmless.

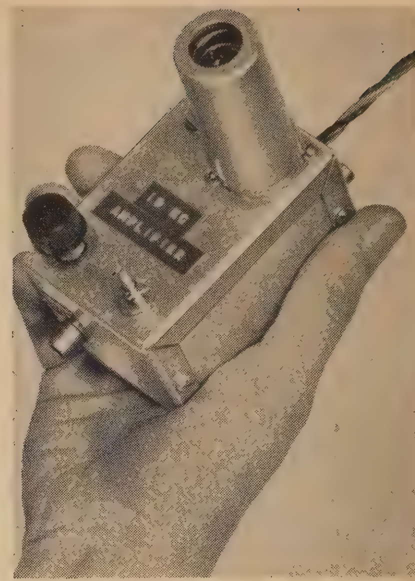
Multiplex circuit alignment

Most of the troubles in FM stereo reception not attributable to faulty parts or low signal strength may be traced to improper alignment of the tuned circuits in the multiplex portion of the receiver. This general step-by-step alignment procedure is applicable to both amplifier-doubler and oscillator-doubler types:

1. Apply a 0.1-volt rms 19-kc signal to the input of the circuit. Observe the 38-kc waveform at the input end of either demodulation diode. (Some more elaborate circuits use diodes in a bal-



The 19-kc pickoff amplifier can be built in an hour or two.



Tiny 19-kc amplifier can be fastened on chassis or case of FM tuner used for test purposes.

anced-bridge configuration, four for each channel. In such circuits, waveform should be observed at the point where the 38-kc voltage is applied to the diode bridge.)

2. In nonoscillator types, 38 kc should be visible. In oscillator types, you should see a waveform similar to that of Fig. 5. (It may not be truly 38 kc, but some frequency close to it.) In the latter case, the waveform may look like Fig. 6. The fuzziness showing above the primary waveform is the small component of synchronizing pilot signal not being locked by the oscilloscope at the fundamental rate of local oscillation.

3. Tune the slugs of every tuned circuit but the 67-kc filter for a maximum, locked waveform. In nonoscillator types, the 38 kc will pass through a definite peak as each tuned circuit is varied. For oscillator types, tune the oscillator tank circuit first, until the fuzziness shown in Fig. 6 disappears. This indicates oscillator "lock-in". Then tune the 38-kc doubler tuned circuit for an increase in 38-kc amplitude. Finally, tune any earlier 19-kc traps or tuned circuits closer to the input. It may be necessary to retune the oscillator itself as the other circuits are peaked, to bring it back into synchronization, as some grid-plate tuned-circuit combinations are highly interdependent. This is even more true in transistor multiplex circuitry.

4. Remove the 19-kc input signal and substitute a 67-kc signal of 0.1-volt rms amplitude. The signal you inject should be very close to 67 kc, but the exact frequency is not as critical as in the case of the 19 kc. You can use regular audio oscillator. Observe the waveform at the output of the 67-kc or bandpass filter and adjust the coil until the 67-kc amplitude is a minimum. The null should be sharp and positive. This alignment step takes care of any interference between SCA (private subscriber broadcasts, such as "Storecast," etc.) which may be going on simultaneously with a stereo broadcast on the same station.

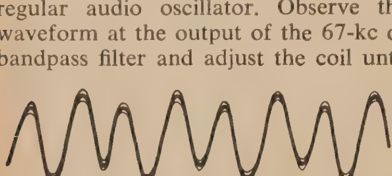


Fig. 6 — Unsynchronized 38-kc signal wobbles and flutters erratically, like this. It should be adjusted to look like Fig. 5.

5. Connect the multiplex circuitry to a source of FM stereo and tune in a station broadcasting stereo. Separation should be apparent even before the final touchup. If the particular station is kind enough to place the announcer on one channel or the other, as many now do, it is an easy matter to adjust any controls for best separation. To do this, turn the balance control of your stereo amplifier to the channel where the announcer isn't, and finalize the setting of the separation control for a null, or minimum sound.

Many multiplex circuits do not have a special separation control, but rely instead upon final local-oscillator touchup for optimum separation. This can be done while listening to stereo, but will seldom require more than a fraction of a turn of the oscillator tank circuit slug in either direction if all the previously alignment steps were followed carefully.

The waveform in Fig. 7 represents the signal you might observe at an instant when stereo is being broadcast, with your scope applied to the head end of one of the demodulator diodes. Naturally, the upper and lower modulations about the stable, 38-kc large-amplitude signal will not stand still long enough for you to see such a well-defined sine wave at top and bottom. But careful observing, even under music conditions, will enable you to see that the modulation along the top edge is different from that along the bottom edge. You will also note that the modulation "fuzz" represents only a small percentage (from about 10% to 30% maximum) of the total waveform amplitude. This tells you at a glance that your internally produced 38-kc carrier is strong enough not to be overmodulated by the incoming audio signals.

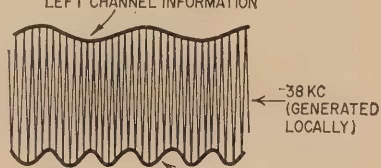


Fig. 7—Composite waveform applied to switching demodulator in switching type adapters looks like this, with constant sine-waves on each channel. Speech or music information varies rapidly, of course.

Multipath distortion

Because of the nature of the FM stereo signal, many service calls in which the complaint is distorted reception are due not to the circuitry at all, but rather to the nature of the incoming signal itself. Often, separation and noise suppression are normal, meaning that signal strength is adequate, but distortion is equally present. The form of the distortion is usually hissy "S" sounds when the announcer speaks, or breakup of high frequencies in music. This trouble is nearly always caused by multipath reception, or signal reflections, and is analogous to ghosts on TV. It doesn't take much theorizing to appreciate how such reflections will upset things after you realize how perfectly the 19 kc must be synchronized with the rest of the incoming signal. A reflected 19 kc, arriving microseconds after the intended one, upsets the delicate phase relationship, and—in extreme cases—causes the local oscillator to waver back and forth between primary and reflected pilot

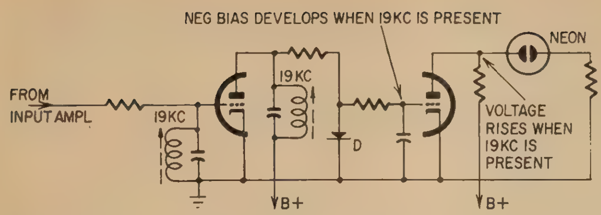


Fig. 8—One kind of neon-lamp stereo indicator circuit. Other indicators may use "magic eye" tubes, incandescent lamps or even meters.

signals. The result is the type of distortion just described. The solution: nothing but a well oriented outdoor FM antenna. The need for a good antenna has been stressed repeatedly in connection with FM stereo and we don't want to belabor the point. Unfortunately, the average FM stereo listener has been led to believe that if his signal *strength* is adequate (that is, no background noise, hiss, etc.), he doesn't need an outdoor antenna. This just isn't so. Often, in metropolitan areas, proximity to a station only increases the problem. If the signal is strong, so are the reflections from nearby structures or elevated terrain. Weaker signals are better off.

Stereo signal indicators

Of late, many multiplex circuits have been incorporating some sort of indicating device to show the listener when a station is broadcasting stereo. Usually, these circuits consist of one or more tuned circuits responsive to 19 kc only, followed by rectification and dc amplification. The resulting voltage is used to ignite a neon lamp (Fig. 8), close an "eye" tube or switch on a light via a relay. These circuits can be tested easily with your 19-kc amplifier fixture described earlier. Remove the neon lamp from its holder and connect a dc voltmeter between the high side of the lamp socket and chassis ground. In the absence of any 19 kc, voltage at the lamp will usually be about 45 to 50. As 19 kc is applied (as it would be by a stereo signal) to the input of the multiplex circuit, the voltage at the neon tube socket should rise to well above 70 volts dc, the firing point of most neon bulbs. Unless there is a component failure, such as diode D in Fig. 8, simple alignment of any 19-kc tuned circuits will usually restore a defective indicator. The neon bulb itself can be checked by connecting it—in series with a 100,000-ohm resistor —across 117 volts ac.

Certainly, no article of this length could hope to cover all the ills that might befall an FM stereo circuit. But now that you know the blocks involved and the general procedure to be used, you will find it easier and pleasanter to familiarize yourself with this newest element of consumer electronics. If the thought of expensive test equipment was what prevented you from entering this field, take heart—you can get along without. END

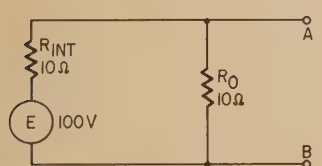
WHAT'S YOUR EQ?

Conducted by
E. D. CLARK

Three puzzlers for the student, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especialy interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011

Answers to this month's puzzles are on page 61.



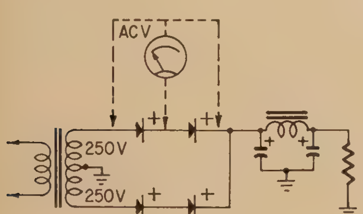
Maximum Power

Load R_0 is matched for maximum power output from the generator or battery. However, it is desired to obtain maximum power in a new load to be connected between A and B. What must be the value of the new load, and what is the power it expends?—*H. D. Varadarajan*

Music—Intercom Trouble

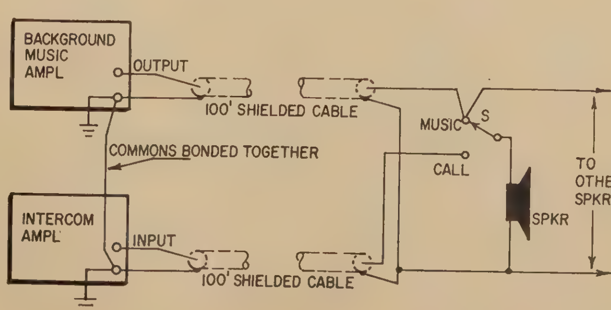
In a combination background music and intercom system, the speaker is connected so that when switch S1 is depressed it will stop the music and connect the speaker to the input of the intercom amplifier to initiate a call. However, the circuit as shown here is not usable in the CALL position. What is the trouble symptom and why does it happen? What can be done to correct it?

Capacitance effects of wiring and switches are unobjectionable. For simplicity, switching for talkback from the intercom is not shown.—*Wayne Lemons*



No Volts

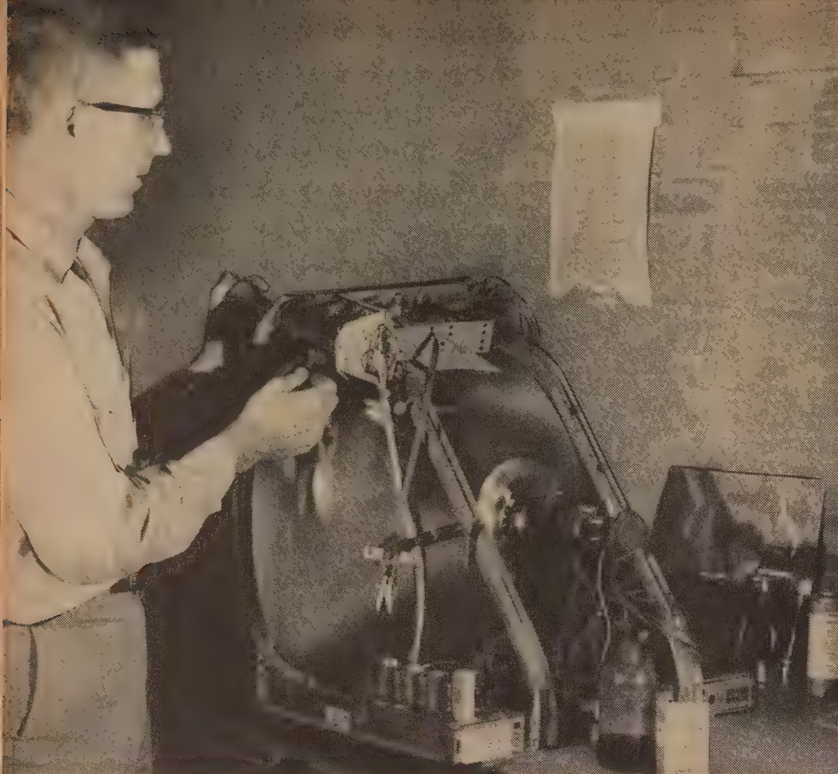
A full-wave power supply has two silicon rectifiers in series on each side. Each diode has a piv rating of 400 volts. A 1,000-ohms-per-volt, rectifier type ac voltmeter on its 300-volt range, with the hot test lead plugged into the OUTPUT jack to block the dc component, is connected in turn across each diode to determine whether the ac voltages across the two diodes are equal. They seem to be: the meter reads zero across each diode. Why?—*Basil Barbee*



RECONDITIONING TV SETS for PROFIT

Fixing up and selling trade-ins can be a real moneymaker. Be sure you can tell the good ones from the bad ones!

By WALTER R. McCARTY*



Cleaning tuner thoroughly is a must. Alignment and tracking are checked after cleaning and after all shields are back in place. Sheet taped to wall details reconditioning process as guide to technician.

IN A BUSY TV SERVICE SHOP, RECONDITIONING used TV sets for resale is often an unwelcome interruption to the normal repair routine. But it can be one of your most rewarding profit sources.

There is only one hitch. If the reconditioned set should fail during the warranty period, the profit dwindles away and may disappear completely. You will have a dissatisfied customer on your hands, and that can be a pretty bad blow to your shop's reputation.

By using a special procedure and checklist we developed for the purpose, we find that our reconditioning is fast and thorough enough to prevent recalls. Our sales personnel have more confidence in selling the sets, the customer is sure of getting "like-new" performance, and the shop, by turning out a better job initially, has more time to devote to other customer services.

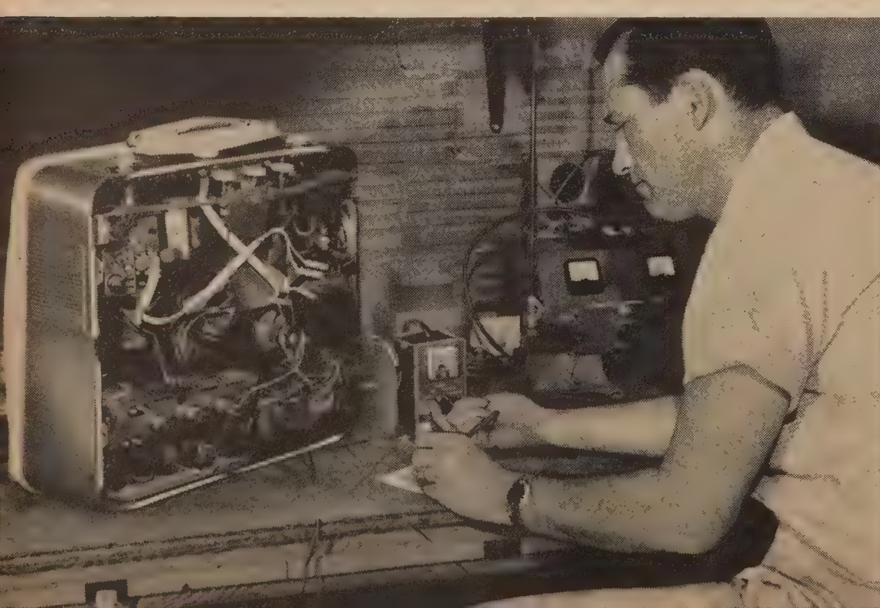
The first decision you will have to make is whether the set is worth reconditioning. One of the biggest mistakes you can make here is to squeeze every possible penny of profit out of the trade-in. If you turn the set over to the service department for just a patch-up repair so it can be sold as quickly as possible, you risk a very unhappy customer and a flock of callbacks.

Somewhere along the line you must decide how long you will guarantee the parts and labor in the reconditioned set. Generally a 30-day unconditional warranty covering all parts and labor is enough. If a new picture tube is installed, the standard new picture-tube warranty will apply. If the old picture tube is good enough, a 6-month half-and-half picture-tube warranty is acceptable. That way, if the picture tube fails within 6 months after the sale of the reconditioned set, the cost of a new tube and of labor is shared equally by you and the customer.

The sales and the service department should decide which sets are to be reconditioned. If you have a sales manager, selling the set will be his problem. The brand name is important, as is the style (portable, table model, console, etc.). In some areas, some styles and makes will sell better than others.

It is up to the service manager or the service technician to decide whether the set is technically worth reconditioning. Here is where the "dogs" should be eliminated. As a technician, you will know approximately what to expect from each make and model. Unfortunately, the best-selling TV sets, namely the portables, are the ones that most often prove to be "dogs." If you have any doubts, better eliminate the set at the beginning rather than after many frustrating and unprofitable hours, either trying to get it working so you can sell it, or trying to repair it after it's been sold.

We regularly get rid of more than half of the sets traded in to us, usually to



Horizontal output stage voltages being recorded on checklist. Instrument at right of set (technician's hand is on the knob) is shop-built checker designed especially for quick horizontal-output measurements.

*TV service manager, Balie Griffith Firestone, Odessa, Tex.

rental agencies or other shops who are better able to bear possible damage to their reputations.

Reconditioning the TV

When a set has been selected for reconditioning, we identify it with a checklist tag attached to a knob. Each technician has an outline of the complete reconditioning procedure above his bench to guide him step by step through the process. Here is a guide to the steps we follow in getting a set back into shape.

1. Replace any obviously defective parts. For the sets that seem to be free from actual defects, or when there is some doubt, follow the checklist for important tests and inspections.

2. Check all tubes on a tube checker. Replace all gassy, shorted and weak tubes. Keep the boxes (see Step 9).

3. Check CRT and replace if advisable. Indicate CRT checker reading on form if CRT is not replaced, and note model number of checker. At an average cost of $17 for a rebuilt picture tube, it is usually wise to replace one unless it is exceptionally good. Being able to say "new picture tube" can ease the sale of the reconditioned set.

4. Clean and lubricate tuner. Scrub contacts with chlorothane and apply contact cleaner and lubricant. Spraying tuner *only* is unacceptable. Check tracking and slug channels as necessary. Scrub contacts with a brush. A Maybelline mascara brush (10¢) with bristles cut down to about 3⁄16 inch makes an excellent tool.

5. Clean controls as required (spraying OK) or replace. Check control ranges, particularly vertical height and linearity.

6. Check B-plus. Make necessary repairs to bring within 10–20% of spaces. Enter voltage on form.

7. Measure horizontal output tube operating potentials with vtvm, vom or analyzer as a check for:

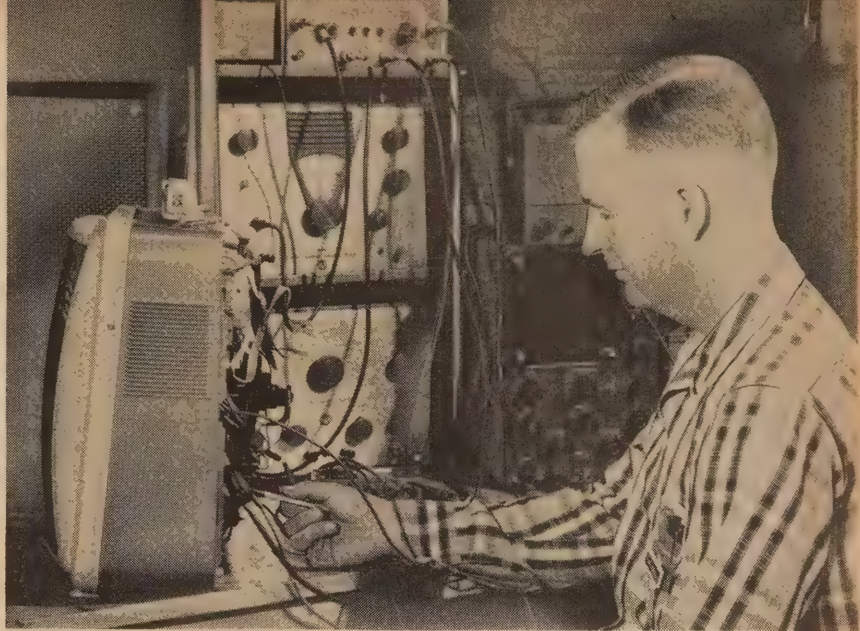
a. *Screen voltage.* Condition of screen resistors.

b. *Grid voltage.* Horizontal oscillator, coupling capacitor, drive control, etc.

c. *Cathode current.* Approximately 100 ma or less for 6BQ6; check tube manual for others. Adjust Horiz. Lin. coil (if any) for minimum current.

Enter measurements on form. Many sets come back in a very short time with horizontal output stage failures. Measuring voltages and currents and fixing anything suspicious during the reconditioning process has been found to be very effective in reducing these failures. The "analyzer" referred to is a horizontal output analyzer of our own design.

8. Check sound circuit and adjustments. Speaker, too.



Aligning a reconditioned set is seldom necessary, but goes quickly with proper equipment. Set with clear, sharp picture sells fast.

BALIE GRIFFITH TIRE CO.

TV Set Reconditioning Check List

1. ☐ Repair Obvious Defects.
2. ☐ Check All Tubes.
3. ☐ Picture Tube OK ________uA.
   ☐ Replaced.
4. ☐ Clean and Lube Tuner.
   ☐ Adjust Tracking.
5. ☐ Clean Controls.
6. ☐ Power Supply OK (B+ 10%) ______Volts.
7. ☐ Horizontal Circuit Working.
   ☐ Screen Voltage ______________Volts
   ☐ Grid Voltage ______________Volts
   ☐ Cathode Current ______________MA
8. ☐ Sound Circuits OK.
9. ☐ Defective Tubes Replaced.
10. ☐ Alignment OK.
   ☐ Aligned RF.
   ☐ Aligned IF.
   ☐ Aligned Sound.
11. ☐ One Hour Air Check.

Technician ______________________

Checklist used in author's service shop.

Completely reconditioned set carries two tags. Card at top is picture-tube warranty. At lower left, shop checklist, completed and signed. This set will have one-year picture-tube warranty and 30-day unconditional parts and service warranty.

9. Put back old tubes (except shorted ones) replaced in Step 2, one by one, noting effect. Use old tubes when no difference in performance is apparent. This is optional. In some cases, as experience will direct, it may be wiser to leave the new tubes in.

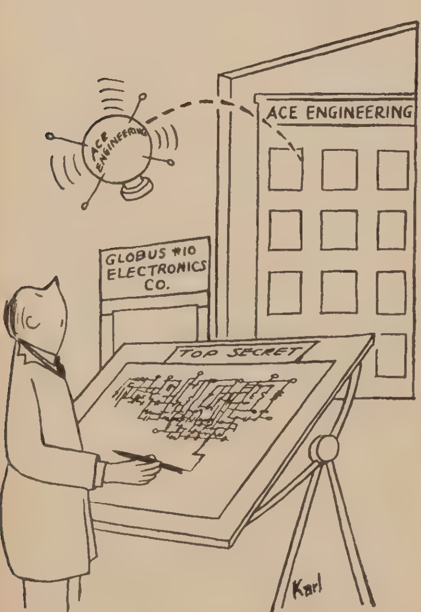
10. Observe picture and determine if rf or i.f. alignment is necessary or advisable. Perform as required.

11. Air check one hour minimum. After air check, tap tubes, especially damper, and recheck all adjustments and picture quality until satisfactory.

12. Sign checklist form. Form will be filed with set owner's record when set is sold. Whenever possible, same technician will be expected to perform subsequent repairs on set. In a shop with several technicians, this step can be very effective and create some competition between them to see who does the best job.

When reconditioning is complete, the checklist form remains with the set until sold. We also write the set's model and serial numbers across the top of the form for sales record convenience, and a code number that gives the salesman the repair cost so he can determine how much expense to recover in the sale. From the sales point of view, the checklist form filled out and signed by the technician is impressive testimony of the thorough reconditioning procedure. The picture-tube warranty card (if a new tube was installed) is taped to the top of the set and filled in when the set is sold.

By doing a good job, the service department will increase customer satisfaction, sales department confidence and store reputation. And if it's done right the first time, chances are there'll be no need to do it over. END



double bridge sensitivity

Simple trick makes Wheatstone bridge more useful

THE WHEATSTONE BRIDGE HAS MANY APplications: sensing light and temperature changes, humidity, etc., as well as the more common resistance and capacitance measurements. Here's a simple variation that doubles the sensitivity of the usual circuit.

All you have to do is make *two opposite* arms of the bridge into "sensing", or transducer, elements, instead of one as is usually done.

Fig. 1 shows the standard four-arm Wheatstone bridge. When the ratio of R1 to R2 equals the ratio of R3 to R4, the bridge is balanced. The voltage at A is the same as the voltage at B, and hence there is no voltage across (and no current through) the detector. If R1 changes, the voltage at A changes also, but the voltage at B stays nearly the same. Now there is a voltage across the detector; its polarity is determined by the direction of the change in R1. If R1 drops, point A becomes positive with respect to B. If R1 rises, A goes negative.

Now hold R1 fixed and make R4 the sensing element (Fig. 2). Exactly the same relationships hold, and you can prove to yourself that, as R4 rises and falls, the voltage at A with respect to B changes exactly as it did when R1 was the variable. In other words, R1 and R4 have the ssame effect on the bridge.

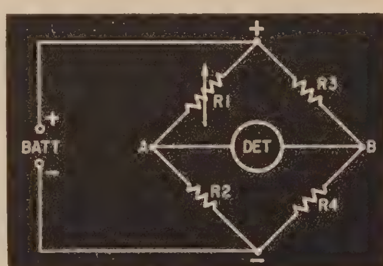


Fig. 1

Fig. 2

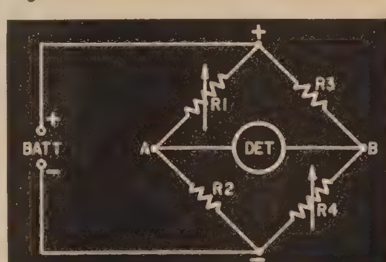


Fig. 3

The next logical step is to vary *both* R1 and R4, and you might guess that, if both are subjected to the same changes (two identical thermistors, for instance, both in the same spot), the net change in the detector's indication will be twice as great as it was when only one element was varied. And that is exactly what happens (Fig. 3).

Besides doubling the sensitivity to a single change (both variable elements working together), this bridge is useful for getting an *additive* reaction. For example, one thermistor can detect indoor temperature changes, and the other, outdoor changes. The detector voltage will then vary with both. [A differential circuit, with R_1 and R_3 used as sensing elements, also suggests itself. Such a device could be used to show the *difference* between two conditions, such as inside and outside temperature.—*Editor*]

If you need a balance control, use an ordinary variable resistor in the R2 or R3 arm of the bridge.

For those who like their theory laced with a little math, here are the equations that bear out the idea.

The equation for detector voltage (E_d) is

$$E_d = E_s\left(\frac{R2}{R1 + R2}\right) - E_s\left(\frac{R4}{R3 + R4}\right)$$

For convenience, let's make the supply voltage (E_s) 2 volts and the detector resistance large compared to the arm resistances.

1. When the bridge is balanced, R1 = R2 = R3 = R4 = 1 ohm (or any other value).

$$E_d = 2\left(\frac{1}{1+1}\right) - 2\left(\frac{1}{1+1}\right) = 1 - 1 = 0 \text{ v.}$$

2. Now make R1 = 0.5 ohm and R2 = R3 = R4 = 1 ohm.

$$E_d = 2\left(\frac{1}{0.5+1}\right) - 2\left(\frac{1}{1+1}\right) = 1.33 - 1 = 0.33 \text{ v.}$$

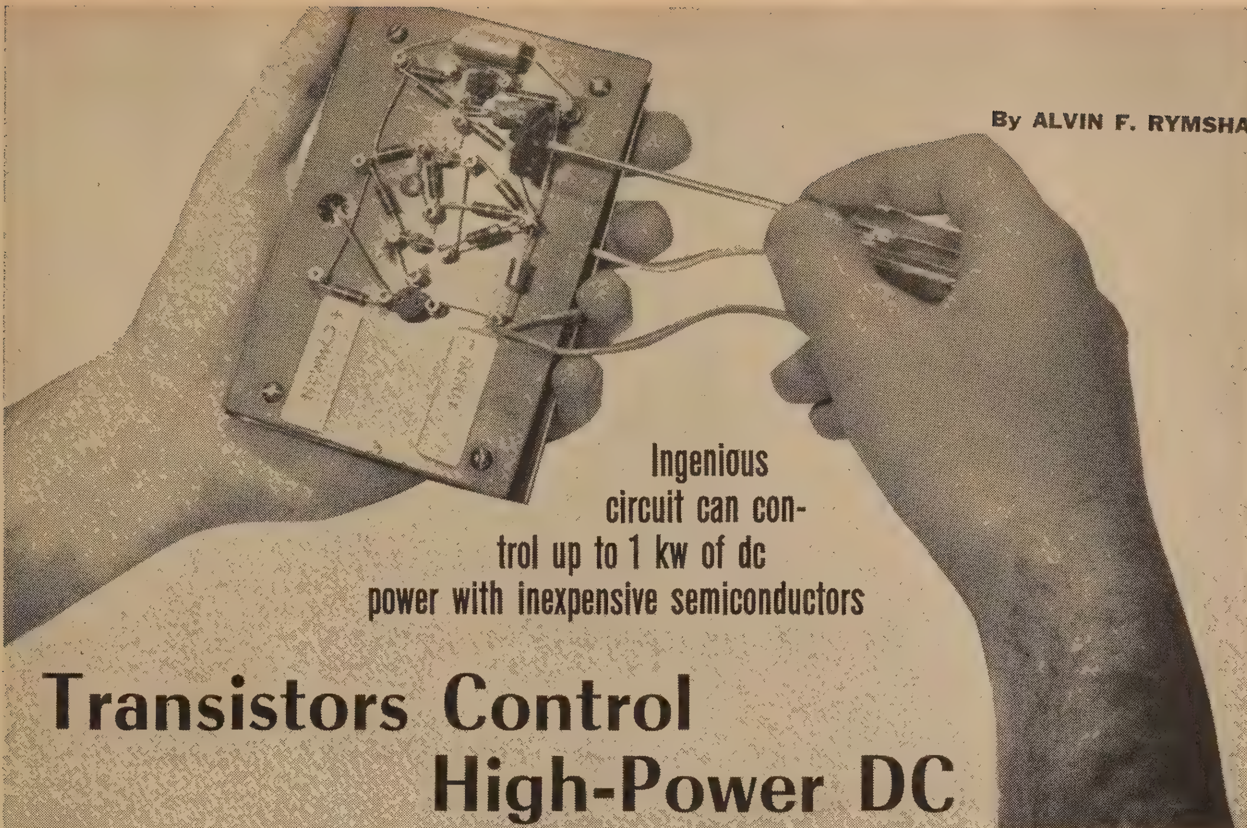
3. Next, make R1 = R2 = R3 = 1 ohm and R4 = 0.5 ohm.

$$E_d = 2\left(\frac{1}{1+1}\right) - 2\left(\frac{0.5}{1+0.5}\right) = 1 - 0.66 = 0.33 \text{ v.}$$

4. Finally, R1 = R4 = 0.5 ohm and R2 = R3 = 1 ohm.

$$E_d = 2\left(\frac{1}{0.5+1}\right) - 2\left(\frac{0.5}{1+0.5}\right) = 1.33 - 0.66 = 0.66 \text{ v.}$$

—*James E. Pugh, Jr.*



By ALVIN F. RYMSHA

Ingenious circuit can control up to 1 kw of dc power with inexpensive semiconductors

Transistors Control High-Power DC

IN MANY HIGH-POWER DC APPLICATIONS, such as motor speed control, battery charging, metal plating, model train control, you need to vary the dc voltage smoothly and efficiently from zero to maximum. The silicon controlled rectifier does the job nicely, but it's expensive compared to most power transistors. These circuits control even storage-battery output—they do not need the interrupted source an SCR needs. And these circuits have no switching-transient interference.

The circuits in this article use no SCR's—just ordinary power transistors, run at their maximum *current* rating, rather than at their maximum *power* rating.

As a series regulator, the pass transistor (Q3 in Fig. 1) must dissipate a fairly high power if a wide variation is required. For example, if a supply must be adjustable between 0 and 30 volts at 5 amperes, at 1 volt out the transistor must drop 29 volts at 5 amperes, or 145 watts. That's a very respectable power, usually beyond a single transistor's rating.

But if the transistor is cut off, there is zero current at maximum volts—zero power; if saturated, 5 amperes at almost zero volts—likewise nearly zero power. Since many loads are affected only by *average* power, if we *switch* the series pass transistor between cutoff and saturation, it dissipates very little power and we are limited only by its maximum *current* rating. By varying the duty cycle (the length of time the transistor is conducting), the average output voltage and current may likewise be varied. A storage capacitor can be used to smooth the output if required, since the "raw" output is a series of pulses.

There are a few factors to be considered: **1.** The transition time between cutoff and saturation must be extremely short. While the transistor is switching, its power rating is being exceeded. The switching time should be in the microsecond region.

2. Peak-current limiting should be provided. The power supply transformer impedance may be enough; otherwise, a choke or a limiting resistor may be necessary.

3. Since the output is a square wave or pulse, some loads may not work well with any reasonable amount of filtering you can build into the supply. In addition, reverse voltage damping may be needed for inductive loads (a good idea for any switching device).

The circuit of Fig. 1 is the simplest possible, but has limitations. A smooth transition from zero output is difficult because of the hysteresis of the Schmitt trigger. The trigger must supply a large base current to the pass transistor (Q3), limiting the maximum current output unless a high-beta transistor is used.

In this circuit, a bridge rectifier supplies dc to the circuit and the load. Potentiometer R1 samples the full-wave rectified waveform and provides a variable input to the Schmitt trigger (Q1 and Q2). As the voltage rises on each half cycle, Q1 conducts at the preset point, instantly switching Q2 off and permitting the voltage at its collector to rise to the supply voltage.

The base of Q3 is connected to

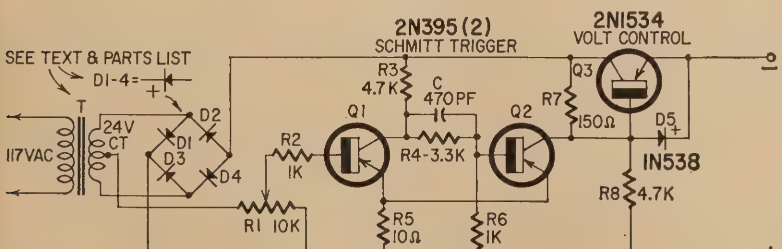


Fig. 1—Simplest switching-control circuit uses 60-cycle ac switching signal, taken across R1 and squared off by Schmitt trigger, Q1 and Q2.

C—470 pf mica or ceramic
D1, D2, D3, D4—1N537 (to 1.25 amp) or 1N1115 (to 3 amp)
D5—1N538
Q1, Q2—2N395
Q3—2N1534
R1—10,000 ohms
R2, R6—1,000 ohms
R3, R8—4,700 ohms
R4—3,300 ohms
R5—10 ohms
R7—150 ohms
T—24-vct "selenium rectifier" transformer; current rating depends on desired output current. Knight 62G331, Stancor RT-201 or equivalent to 1.25 amp; Knight 62G333, Stancor RT-204 to 3 amp

this point and current will flow through R7 to the base, turning on Q3, which saturates and appears as a virtual short circuit. The output voltage rises to maximum.

When the voltage across R1 falls to a sufficiently low value, Q1 is cut off and Q2 is turned on, bringing the base of Q3 to nearly ground potential and cutting it off. The output voltage falls to zero. By adjusting R1, the length of time during each half cycle that Q3 is turned on may be varied.

Since the trigger switches state at a slightly lower voltage than that required to turn it on, it is impossible to reduce the "on" time to a very narrow pulse. The circuit will step from 0 to about a 15% duty cycle as a start, and only about 90% as a maximum. Fig. 2-a illustrates this. The circuit of Fig. 1 should control up to about 3 or 4 amperes, maximum.

The minimum-width pulse can be narrowed by speeding the voltage fall time—by using a sawtooth to drive the trigger, rather than a half sine wave. Fig. 2-b illustrates the improvement. The circuit of Fig. 3 includes this improvement, and can control more current.

An inexpensive unijunction transistor is used to generate a free-running sawtooth (it could be synced to the line). This sawtooth is applied to the trigger. The adjustment is now very smooth from zero through an extremely

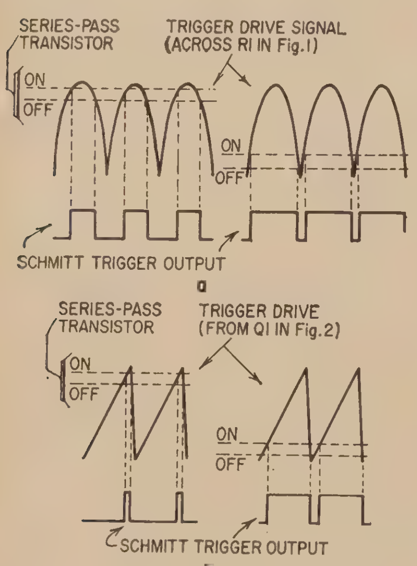
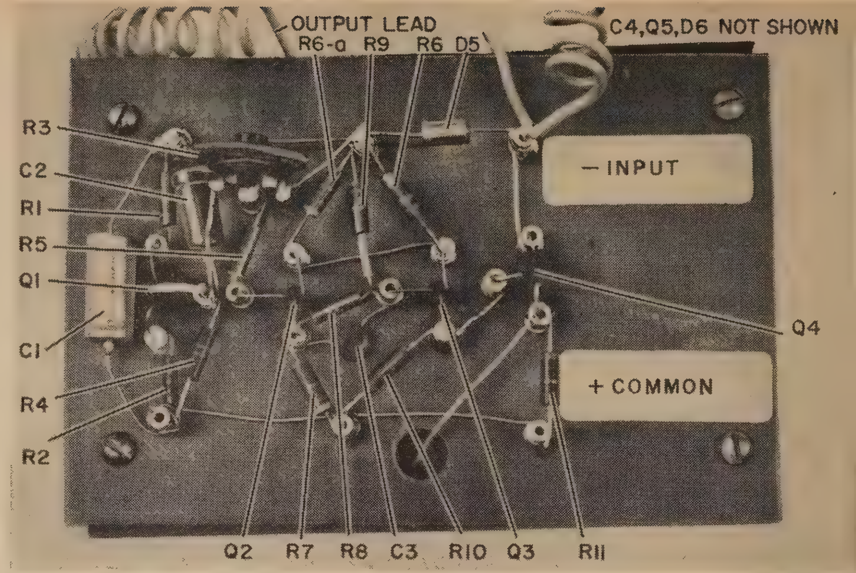


Fig. 2-a—Switching principle. Series pass transistor (Q3 in Fig. 1) is switched between saturation (near-zero resistance, low voltage drop) and cutoff (very high resistance, low current flow) by half sine-wave developed across R1 in Fig. 1. Transition between states must be short, or transistor will overheat; (b) shows more rapid on–off transition (narrower pulses from trigger) with sawtooth excitation.



Wiring of author's experimental model. This board includes only control components; transformer and bridge rectifier are not shown. "R6-a" is extra 470-ohm resistor shunted across R6 to reduce its value slightly.

narrow pulse to nearly 100% output. Actually, at some point above maximum, the trigger will lock up and hold the output full on. In this circuit, trigger Q3 does not drive the pass transistor directly, but a Darlington driver, Q4. This permits controlling up to 30 amperes if a 2N2152 is used. At 30 volts output, this represents nearly a kilowatt! The driver must supply a base current of about an ampere, so a 2N1954 or similar device is used.

Several other changes: inexpensive silicon planar epitaxial transistors are used in the trigger for better temperature stability and reliability. They cost less than equivalent germanium devices would. These could not have been used as well in the first circuit to drive a p-n-p pass transistor since the drive pulse is inverted and only about 85% of maximum output could have been obtained. (Of course, if an n-p-n pass transistor had been used, the silicon planars would have been all right.)

The output transistors in both circuits run surprisingly cool, considering the power involved. More to the point, the circuits can be built from common parts. The trigger is no more complex than the one for an scr, and possibly simpler. The transistors were chosen for economy. The circuit can be used at higher voltages if you choose higher-voltage transistors.

If the transistors are modified for different current levels, sufficient base current must be provided to oversaturate the pass transistor at the highest

C1—100 μf, 50 volts, electrolytic
C2—0.1 μf, paper
C3—470 pf, mica or ceramic
C4—1,000 μf, 25 volts, electrolytic
D1, D2, D3, D4—1N1200A or Motorola MR323 to 8 amp
D5, D6—1N538
Q1—2N2160 unijunction
Q2, Q3—2N2713, 2N2714
Q4—2N1954, 2N525
Q5—2N1073 or 2N1046 to 10 amps; 2N2152 (to 30 amp)
R1—150 ohms
R2, R10—1,000 ohms
R3—pot, 100,000 ohms, linear
R4—47,000 ohms
R5, R11—10,000 ohms
R6—56 ohms
R7—4,700 ohms
R8—680 ohms
R9—3,300 ohms
T—24-v "selenium rectifier" transformer; current rating depends on desired output current. Knight 62G335, Stancor RT-208 or equivalent to 8 amp; Stancor RT-2012 or equivalent to 12 amp

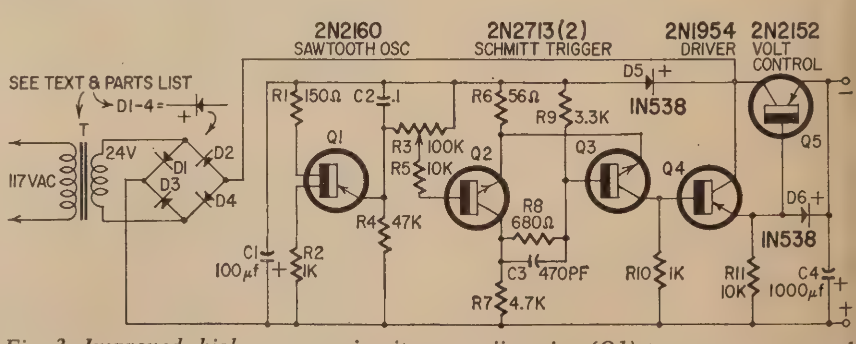
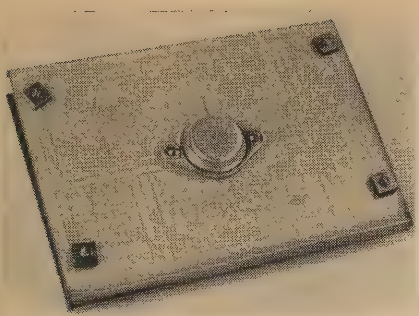


Fig. 3—Improved, higher-power circuit uses unijunction (Q1) to generate sawtooth pulses for more efficient operation. Driver stage (Q4) supplies enough current to "swing" even large power transistors.



Only the series pass transistor needs to be mounted on a heat sink.

current level required. During the cutoff cycle, the base must be slightly reverse-biased to insure complete cutoff. Power transistors with a high collector leakage (I_{co}) may require a very low value for R8 (R11 in Fig. 3), and should be avoided. The silicon diode from base to emitter of the power transistor prevents the back bias from exceeding the base–emitter breakdown (V_{be}) rating of the transistor.

Design notes

Any power transistor will serve as Q3 in Fig. 1 and Q5 in Fig. 3. The 2N2152 is a low-cost 30 amp 170-watt transistor. I used a 2N1073, which will handle 10 amps—I just happened to have one. The criteria to check, once the maximum current is decided upon, are high beta and low leakage. A leaky transistor will limit the lowest output that can be obtained; a low-beta unit will require a high base drive and may overheat on high currents. You can always use a heavier transistor, and there will probably be better beta holdup over the current range.

The circuit of Fig. 1 will control up to 4 amps if the output transistor has a high beta. Base current must be supplied from the Schmitt, which is somewhat limited in current capacity. Power capability will be about beta/10 amperes, provided the maximum current rating of the power transistor is not exceeded, so a transistor with a beta of over 40 could handle 4 amperes.

Regulation of the voltage supplied to the load is related to only one function of the control circuit: saturation resistance of the pass transistor (Q3 in Fig. 1 or Q5 in Fig. 3), provided it is *saturated*. This means supplying enough base drive. Typically, the resistance will be less than 0.1 ohm. If an infinite (perfectly regulated) supply were used, the regulation would be perhaps 2 to 3 volts up to 30 amp. Remember that the beta of most transistors drops at high currents, so we must not *assume* a transistor is saturated. If it stays cool, it is OK. If it gets hot, it is not being saturated. The actual regulation will depend also on drop in the transformer winding, rectifiers and storage capacitors. END

MEASURING NANOAMPERES

Dc amplifier plus microammeter measures leakage current, high resistances, makes great "tvm"

CONVENTIONAL DC METERS ARE AVAILable down to about 15 microamperes full scale. For still weaker currents, a dc amplifier may be added ahead of the meter. For example, with a gain of 100, the full-scale reading of 15μa meter becomes .15 μa or 150 nanoamperes. This way, you can measure such weak dc as the output of a thermocouple or the reverse flow through a silicon diode.

Fig. 1 shows a very stable balanced transistor amplifier. Temperature effects are largely balanced out because the transistors are affected equally and oppositely. These transistors (Texas Instruments) cost less than $1.50 apiece. Because of their low cost, you may wish to obtain several and use those with highest gain. I had no trouble obtaining a gain of 100 from the circuit of Fig. 1. Several transistors all provided the desired gain.

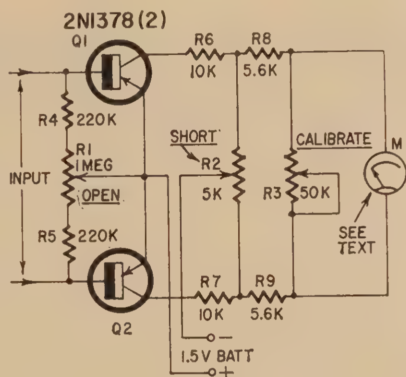


Fig.1

M—microammeter (see text)	R6, R7—10,000 ohms
R1—pot, 1 megohm	R8, R9—5,600 ohms
R2—pot, 5,000 ohms	V1, V2—2N1378
R3—pot, 50,000 ohms	Sockets for above
R4, R5—220,000 ohms	BATT—1.5-v dry cell
	Mounting board and hardware

I use this circuit in conjunction with a 20-μa meter, so my full scale is 200 nanoamps.

To adjust the circuit, *short-circuit* the input (base to base) and adjust R2 for zero reading. If transistor matching is not good, you may not be able to zero. In that case change one of the 220,000-ohm resistors. The second step is to *open* the input terminals and adjust R1 for zero. These adjustments need only occasional resetting.

To calibrate the device, I apply a known current (Fig. 2) and vary R3. For example, a mercury cell (1.345 volts) passes about 156 nanoamps through 8.6 megohms. (Input resistance of the transistors is negligibly small.) Set R3 for the required deflection. In my case this is 15.6 on the 0–20 scale. Note that R3 does reduce the overall gain of the amplifier since it shunts out some of the current, but I find adequate gain is available.

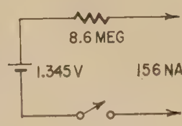


Fig.2

To read volts, connect a multiplier resistor in series with the instrument. Since my full scale is 0.2 μa, I need 5 megohms for full deflection when 1 volt is applied. This is, in other words, a 5-megohm/volt circuit. To measure 20 volts full scale I need 100 megohms. This instrument is about 10 times better (higher input impedance) than a conventional vtvm, on this particular range.

To measure a high resistance, connect it in series with a dc source and measure the resultant current. For example, assume that you use 1.5 volts in series with an unknown resistor, and that the deflection is 100 nanoamps (mid-scale). By Ohm's law, the resistor is 1.5v/0.1μa) or 15 megs. Again, the instrument performs better than an ordinary vtvm. My vtvm ohms scale indicates only 9 megohms at mid-scale.

All parts for my nanoamp meter (except the d'Arsonval instrument) are mounted on a perforated 4¼ x 1½-inch board, mounted in a metal box which houses the 0–20-μa meter. If desired, the auxiliary calibration circuit may also be mounted in the meter box, or it may be plugged in.—*I. Queen*

Bass-Reflex Enclosures Design and Construction

THAT'S THE TITLE OF A BOOKLET JUST published by Electro-Voice, attacking the problem of bass-reflex enclosure in a semi-novel way. Though ducts in bass-reflex enclosures have long been used to compensate for small internal volume, this booklet shows how using fairly long ducts makes it possible to reduce enclosure size to near absolute minimum volumes.

A chart gives the duct lengths for enclosures of various sizes used with various speaker models, and make it possible for the user to select the largest duct possible for a given cabinet volume. The booklet also offers useful design and construction hints—some not widely known.

While the figures are based on Electro-Voice speakers, tolerances appear to be rather wide, and there is little question that the information can be used with all good speakers.

The booklet is available at 25¢ from Electro-Voice, Inc., Buchanan, Mich.

Start An Audio Service Business?

If you're just getting into service, or thinking of expanding, consider specializing in hi-fi.

By LARRY EUGENE

HAVE YOU CONSIDERED THE ADVANTAGES of specializing in hi-fi audio? Virtually every home today has a "hi-fi", so-called, whether it be an elaborate custom system or a table radio with two speakers. This equipment will eventually require service.

Stereo—first tapes, then discs and finally FM multiplex—has brought its own service problems. Transistors are replacing tubes in all kinds of audio equipment. Tape is starting to compete with discs. It is beginning to appear that only a specialist can keep up with new developments in the field.

But before you rush out to put up a sign, "No TV Servicing," take a good look at what you need to be a specialized service agency in audio, with a number of authorized service agency (a.s.a.) franchises.

Most important is *mechanical know-how*. According to Leonard March, president of Electronic Engineers, Inc., of Chicago, whose specialized shop is featured on our cover this month, "80% of changer and tape recorder problems are mechanical. It has been our experience that most electronic technicians are weak when it comes to mechanics. There's an entirely different set of skills involved in mechanical servicing, and unfortunately very little time is spent on these skills in most electronic schools."

March's associate, Jerry Man, adds: "Our solution is to train our own men in mechanics. In a specialized shop such as ours, we have the best training laboratory available. Not only does the technician handle a much higher volume of units with mechanical service problems, but because each of our technicians specializes in certain equipment, he is able to accumulate in a short time the experience that might otherwise require years."

As one technician at Electronic Engineers put it, "Servicing phonos and recorders is almost like servicing automobiles—you've got to be a good mechanic."

Next important item is the *test equipment* your specialized shop will require. You will need some lab-quality, professional test units. To move audio jobs rapidly and still maintain high standards, such equipment is a must. Remember: test equipment should be better than the units being serviced with it.

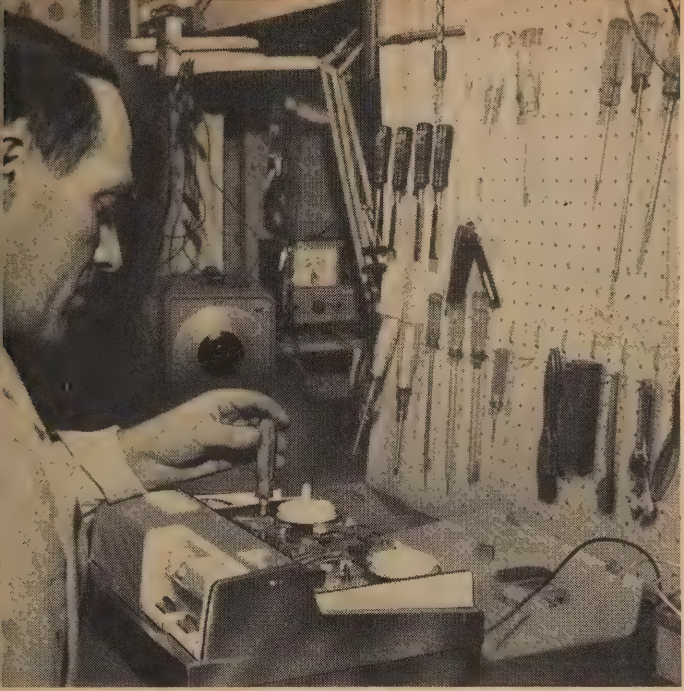
Basic test units you probably have include an audio oscillator, rf signal generator, vom, vtvm and oscilloscope. For an additional $2,500, you can add equipment for servicing tape recorders, record changers, stereo amplifiers and tuners with the highest efficiency and minimum callbacks.

This supplementary equipment includes a wow and flutter meter, distortion analyzer, a multiplex generator and an electronic counter. Also useful are standard level alignment tapes, 3-kc test records and tapes, a head demagnetizer, and spring scales (postal type will do). A tape viewer for checking track spacing is handy, but not essential.

Wow and flutter meter. Measures speed variation of tape recorders and phonographs and sound movie projectors. (RADIO-ELECTRONICS published a story on a build-it-yourself flutter meter on page 24 of the March 1964 issue.)

Distortion analyzer. This versatile piece of test equipment should be purchased as soon as possible. Some types are for harmonic distortion only, others for intermodulation distortion only, and some measure both kinds. With them you can check distortion in any device, even phonograph pickups and tape recorders, by using test records and tapes. Most such meters also include sensitive ac vtvm's to measure 10 mv or less.

Multiplex generator. Essential for properly aligning and repairing FM stereo equipment. It is expensive, but you cannot do without it if you expect to service multiplex units properly. Following Electronic Engineers' successful average charge for alignment and repair ($23.50 plus parts) you will soon re-



Tape recorder service is a large part of total business. Here, technician adjusts mechanical linkage on Wollensak.

Good tape recorders deserve regular checks for wow and flutter. This technician is using compact Donner 2800 meter in overhauling Concord recorder.

cover its cost. If you select a model with an rf output, you can transmit a signal throughout your shop, providing a single multiplex test source for all your technicians.

Spring scale. Wow in tape recorders can be caused by erratic or incorrect holdback and takeup tensions. An ordinary 8-ounce postal scale can be used to check them. A larger scale can be used for pinch roller pressure.

Digital counter. Used to check tape recorders for speed accuracy. (See "Cover Story" box.)

Alignment tapes. Available in three standard speeds: 3¾, 7½ and 15 ips. Use them for checking head alignment and for adjusting playback response and level.

Special tools for special operations are usually supplied by the equipment manufacturers.

Stocking parts

Since tape recorder and record changer parts are seldom universal, you will need a much more extensive *parts inventory* than for TV service. Electronic Engineers estimates that for each manufacturer whose equipment they service as an a.s.a., they have a parts inventory of between $700 and $1,000, their cost.

This requires not only capital, but storage space. Electronic Engineers uses banks of storage drawers arranged by category of parts, such as "belts," "spindles," "capstans," etc. Within these categories they arrange the drawers by manufacturer. Thus, if you need a V-M spindle, you go to the "spindle" section, then look for V-M and the appropriate part number. Electronic Engineers also has an inventory card on each of the approximately 21,000 parts they stock.

As an a.s.a. you will depend on manufacturers for parts lists and technical data. Be sure to find out what arrangements he has to supply you with this vital information.

The growing hi-fi market has attracted many foreign manufacturers. They need authorized service agencies (a.s.a., for short) in the US. They are more likely to appoint as their a.s.a. the shop that *specializes* in audio.

Moreover, foreign firms often need stateside quality-control inspection. Transportation over long distances takes its toll, often in hidden damage. An initial quantity of tape recorders was shipped to Electronic Engineers by air. Inspection revealed no problems. Later shipments to the States did not undergo quality-control inspection, and a rash of in-warranty service calls resulted. "We found that every one of the units, which had been shipped by surface, had lost their lubricants as a result of many weeks in the hot holds of ships," March says. "We now handle all stateside Q.C. inspection for this manufacturer." Last year, he was invited to visit Japan to conduct seminars on quality control. He was there for a month, and helped set up Q.C. procedures in seven factories.

Among the most important advantages of being an a.s.a. is the extra discount on parts you get from your manufacturers. It enables you to handle servicing jobs for distributors and dealers. By discounting the *parts* to them, you make it economical for them to give their specialized service jobs to you, because they can make a profit on the parts. And in time, they will come to you just for parts which you stock.

Most makers send out regular service bulletins to all a.s.a.'s. As field complaints reveal problems, they are written up and passed on to you. In this way, you benefit from the experience of every other a.s.a.

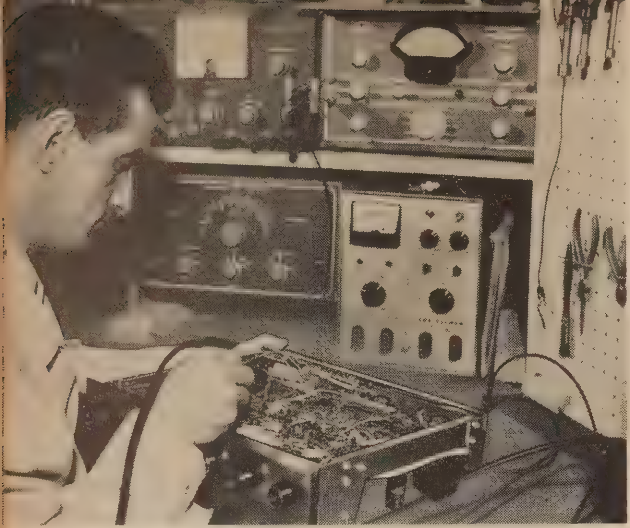
COVER STORY

Our cover this month shows an Ampex F4460 tape recorder being checked for speed accuracy by Paul Zurales, a technician in the shop of Electronic Engineers, Inc., Chicago, Ill. Equipment shown: At top, Hewlett-Packard electronic (digital) counter; just below it, a Hewlett-Packard distortion analyzer; small unit on bench at left, a Varo Flutter Meter.

Advantages of an electronic counter in checking tape recorder speed, according to Electronic Engineers, are high accuracy, fast work and simplicity.

A 3-kc tape is played on the recorder. The signal is fed into the digital counter, which gives an exact reading of the frequency in cycles. (Each of the columns on the counter represents one digit, and has numbers from 1 through 9 and zero. The impulse from the tape lights up the proper number in each column.) Percent of speed is then readily calculated. For example, if the counter reads 3,030 cycles, the deviation is 1.0% (rms). Commonly acceptable speed deviation for professional machines is 0.2% fast or slow; for home-type units, 3% fast and 1% slow.

To check turntable speed accuracy with the digital counter, the same procedure is followed, except that a 3-kc test record is used as source.



E.E. technician at work on a Scott stereo amplifier. On top shelf, Heath intermodulation distortion meter (left), B & W harmonic distortion meter. Heath audio oscillator (left, bottom) and Fisher multiplex generator complete the setup.

You also will benefit from manufacturer advertising and referrals. You will be able to participate in Red Book listing programs and local advertising. Occasionally, national advertising lists authorized agencies around the country. All these programs are effective, because the owner of an expensive tape recorder, for example, prefers to have it serviced by an *authorized* agency.

Purchasers of new equipment in your area, of course, will be referred to you. These new prospects then become familiar with your service during the warranty period, or else call you after it expires, since your name was given to them as the a.s.a. in their area.

The in-warranty service jobs invariably are *not* profitable. But if you accept them as inevitable, and handle them as efficiently as possible, you can use them to build good will and gain new customers. Remember that the impressions the customer receives during the warranty period will influence him greatly in deciding where to take his equipment for repair later.

What does a manufacturer look for in an a.s.a.? In the early days, the only question asked was, "Can you service?" Now he is very much interested in the shop's *integrity*. The unfavorable publicity generated by a small minority of service shops has caused the manufacturer (as well as the public) to be cautious about service agencies. He looks for a shop that has a reputation for satisfying its customers.

He also is interested in the caliber of personnel. Quality and amount of test equipment receives careful scrutiny. Orderliness and space are factors, too, since they are signs of an efficient shop.

Finally, a manufacturer seeks a shop that has adequate *insurance* to protect the cutomer's property. Too often shop owners neglect this item, but it can prove to be a serious obstacle to receiving appointment as an a.s.a.

You don't have to *start* big. As an example, Electronic Engineers started out in 1950 with only $200 capital. Gradually, over several years, they moved toward specialization, taking on service responsibilities for manufacturers of changers and tape recorders. Now TV servicing represents less than 1% of their total volume. V-M was their first servicing franchise. Their first tape recorder franchise came from Ampex. They are also fully licensed and equipped to service CB and ham equipment.

They now are the authorized service agency for 85 manufacturers. Annual volume is $250,000, at least 50% of which comes from tape recorders. Parts inventory is valued at $60,000 at cost. Electronic Engineers has 15 employees, working in recently expanded, air-conditioned facilities, which now total 12,500 square feet. Each man has his own U-bench with 36 square feet of space, his own tools and bank of test equipment.

At E. E. all technicians specialize—on tuners, domestic recorders, foreign recorders, professional recorders, etc. A unit that comes back is assigned to the original technician. Thus, he learns from his mistake. If it's new repair work, he soon becomes familiar with the vagaries of that particular unit. Says Jerry Man: "We find this internal specialization definitely produces greater proficiency and motivates a personal interest."

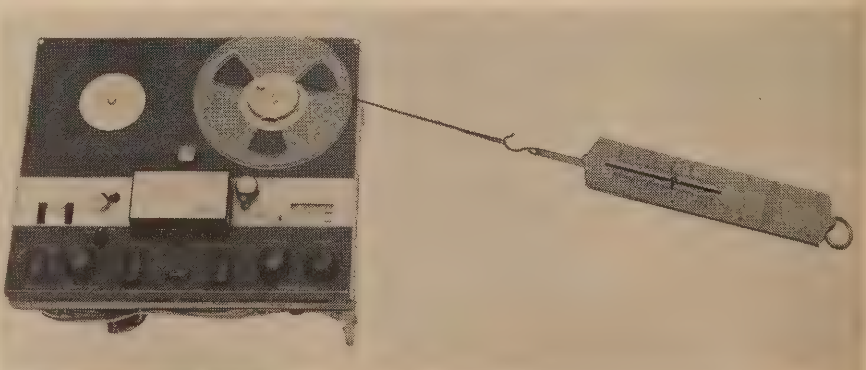
Does Electronic Engineers have a minimum? "Definitely, yes. There must be a minimum charge. For example, to check a tape recorder, our minimum is $7.50. This means we'll troubleshoot the unit, locate the problem *and correct it*. We then quote the cost of parts to the customer. Nine times out of ten, he says, 'Go ahead, fix it.' Of course, we already have 'fixed it.' If he says no, we remove the new parts and return the unit to him as received. The minimum charge has covered our labor and we haven't lost anything. In our opinion, this is the only way to do it. In the long run, it costs the customer no more, and it builds better customer relations because there is a clear understanding."

They also emphasized the importance of turning down certain jobs. "If a customer won't agree to our minimum charge, we politely refuse the job," March explained. "We're interested only in bona fide jobs that can be scheduled through the shop."

Their seasons break down this way: First quarter, heavy in-warranty jobs; second quarter, slow; third quarter, slow and then picks up; fourth quarter, peak volume (fall and pre-Christmas business).

To maintain level volume during the off season, they use direct-mail promotions. Their last one was a "special" in cleaning, lubricating and adjusting any portable phonograph or home tape recorder. Results exceeded all expectations. The mailing consisted of an 8½ x 11 sheet listing exactly what work would be done. Price for the phono special was $9.99 plus parts; for the recorder special, $12.95 plus parts. It was sent to their list of regular customers only.

If you're now making a fair profit out of your service operation, and the volume keeps you busy enough, you may be better off to leave well enough alone. On the other hand, if you're looking for ways to increase your volume without jeopardizing your profit ratio, and you're an adventurer at heart, consider audio service. END



Ordinary postal scale is handy for measuring holdback and takeup tensions in tape recorders. Capstan roller pressure can also be checked.

WHAT'S NEW

FUEL CELL BECOMES OXYGEN DETECTOR in recent discovery by Westinghouse Research Laboratories. Normally, cell generates electricity when oxygen is fed to one side and hydrogen to the other, but without normal fuel supply, cell can detect 1 part per million of oxygen. Here, W. M. Hickam of Westinghouse monitors amount of oxygen removed by his lungs with fuel-cell detector (in metal "can"). Discovery could be useful in medical and biological research, diagnosing lung disease and measuring oxygen exchange.

LASER ROD's precise finishing is demonstrated in this shot through a laser rod. Camera looked through almost 20 inches of as-drawn Corning neodymium-doped soda lime silicate laser glass, 1½ inches in diameter, with ends polished flat to 1/10 wavelength and parallel to 10 seconds of arc. Display rod, in man's hands, is about 1 inch in diameter and almost 2 feet long, finished to same specifications.

MAP OF MANHATTAN ISLAND and neighboring parts of New York City are fired directly onto inside of CRT faceplate. Specially prepared tube was part of Corning Glass Works display at recent IEEE convention in New York, demonstrating company's technique of making large complex internal graticules for CRT faceplates. Firing patterns on inner rather than outer surface eliminates parallax error.

FIFTEEN YEARS OF ELECTRONICS displayed here on new IBM "System/360" console: vacuum tubes, used in first electronic computers, gave way to transistors, which in turn are yielding to tiny transistor chips (50,000 in a thimble) used in System/360 computers. Chips are mounted, with diode chips, printed resistors and "wiring", on the little module block lying among them.

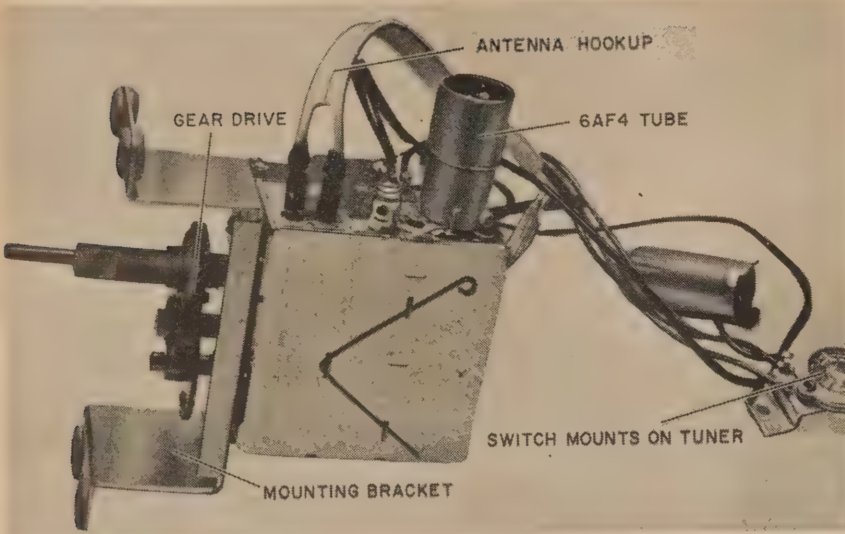


Fig. 1—An Admiral 100–200 uhf tuner.

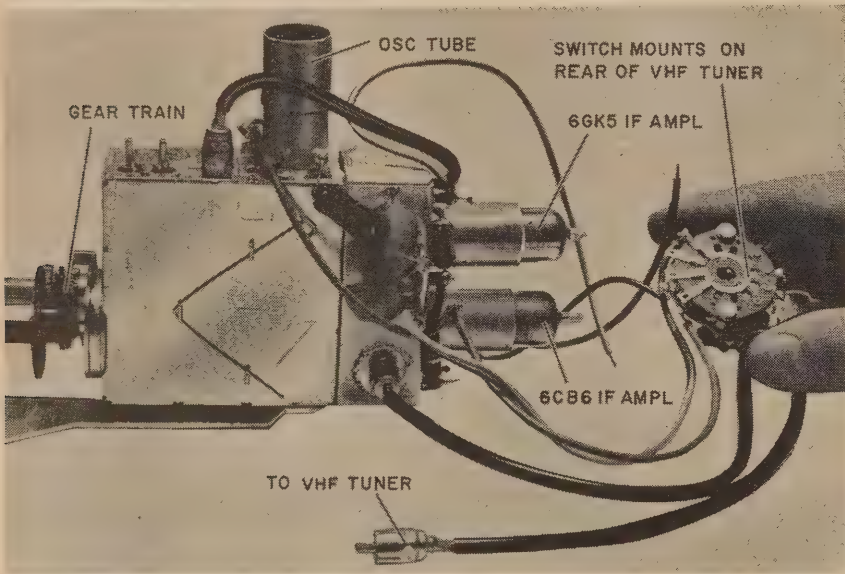


Fig. 2—RCA DK86 3-tube tuner. Its circuit appears in Fig. 4.

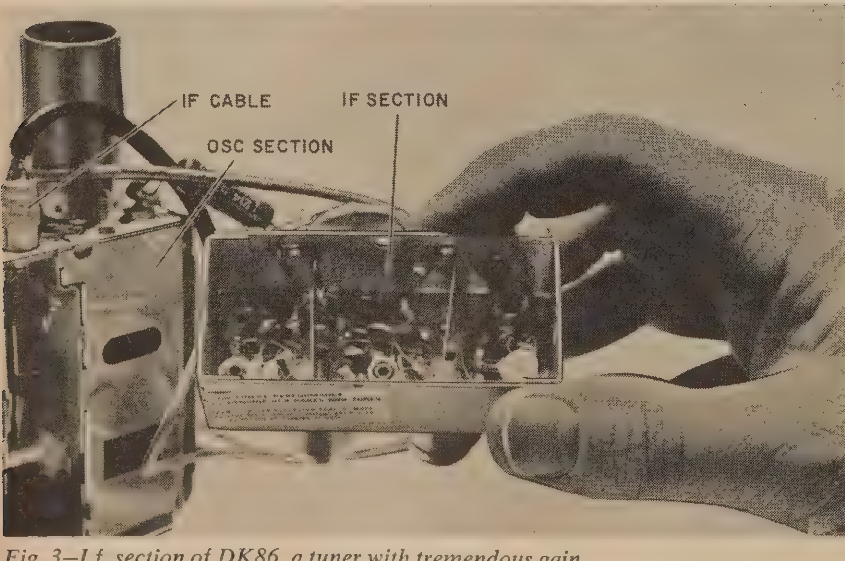


Fig. 3—I.f. section of DK86, a tuner with tremendous gain.

Installing & Trouble-shooting UHF TV

PART II

Installing uhf adapters in existing sets

By HOMER L. DAVIDSON

VHF-ONLY SETS WILL NEED UHF TUNERS added as uhf appears in your area, and you can make a few bucks by installing them.

The RCA DK71, DK86 tuners and the Admiral 100 and 200 are add-on types. All holes are drilled for a corresponding mounting bracket. Figs. 1 and 2 show the two types. The DK86, the latest RCA tuner, has three tubes: a 6AF4 oscillator, and two i.f. amplifier tubes. The converted uhf signal is fed directly into the i.f. strip of the TV receiver. Fig. 3 shows the i.f. section of the tuner. The circuit of the DK86 is shown in Fig. 4.

An advantage of the DK71 and DK86 tuners is that they can be installed in any TV receiver with a 41-mc i.f.

If you have a non-RCA brand to convert to uhf, one of the first requirements is a means of actuating the wafer-switch assembly which fits on the rear of the vhf tuner. If only a small piece of shaft sticks out at the back of the tuner, the shaft must be lengthened. Grind a piece of brass volume-control shaft down on one side so the shaft will fit into the wafer assembly. Place a piece of tubing over the two end pieces as shown in Fig. 5. (Tubing from an old auto antenna mast works fine.) Now sweat the two together. Be sure the flat

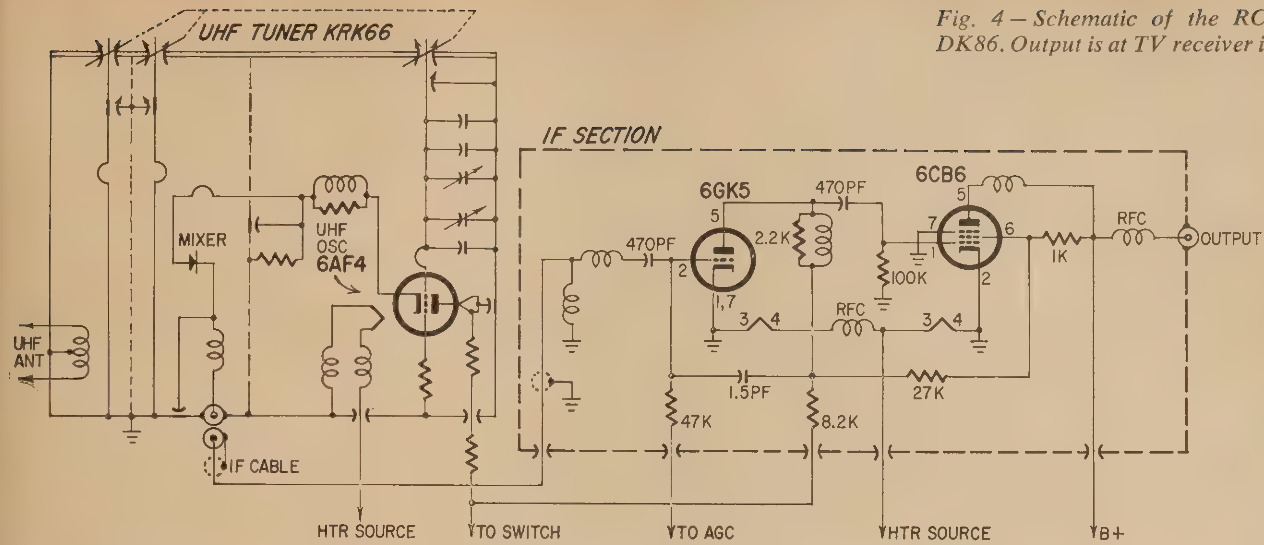


Fig. 4 — Schematic of the RCA DK86. Output is at TV receiver i.f.

side matches the wafer switch and is rotated correctly to align itself with the vhf tuner shaft when installed in the rear of the vhf tuner. The vhf tuner should be turned to the "uhf" position or to an unused channel.

Hook it up

After the switch is mounted, mount the uhf tuner itself, either on the side of the cabinet or through the front panel. Several mounting brackets are provided with each tuner.

Then select the B-plus lead going to the vhf chassis (generally a red wire). Cut the wire or extend it to terminal No. 9 on the wafer assembly. Take the B-plus lead wire that was cut in two and extend it to terminals 10 and 11. Strip the red lead back about ¾ inch and use it as a jumper between 10 and 11. Solder the green wire to the agc connection and the brown lead to the heater terminal. This tuner is for a parallel heater hookup.

Remove the i.f. link cable from the jack on top of the vhf tuner. Most of these are soldered in, but some use a phono plug. Plug the top link cable from the switch assembly into the jack or connection that held the i.f. cable. Plug the i.f. cable into the jack on the wafer assembly. If there is no plug on the i.f. cable, install a phono plug here. Dress the uhf antenna cable away from metal portions of the chassis and cut it to length. Tape up all wires going to the chassis to the i.f. cable. This may seem like a lot of hard work, but it assures another sale on a new or good used TV receiver that would not sell in a uhf market otherwise.

In a DK86 there are two more tubes to check in case of snow. A snow adjustment coil, is located at the top rear of the i.f. section. First tune to an unused portion of the uhf band. Adjust the coil for maximum snow. The other coils should be adjusted only under very "snowy" conditions.

A few hints on this tuner: The plastic gear shaft, where the indicator knob mounts, is easily stripped. People will try to turn the tuner beyond its stops and strip the plastic gears. Also, be very careful with the wafer assemblies; they break very easily.

If the tubes and crystal mixer have been replaced and the picture is still snowy, check the shielded cable connections. These will sometimes break off at the assembly switch. Make sure the wafer switch assembly contacts are clean. Check the antenna connections to the uhf tuner itself. Last, check the variable capacitor for shorted plates in the cavity sections.

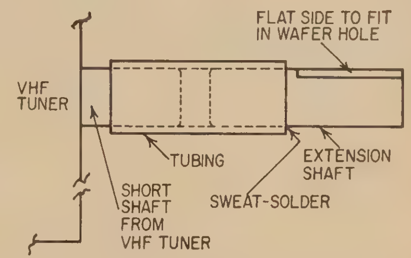


Fig. 5—How to extend vhf tuner shaft to operate transfer switch.

In a future article, we plan to examine top-of-the-set converters. END

DETECTING TURNTABLE WOW

"Wow" is defined in the glossary of hi-fi terms as a periodic variation in speed which can adversely affect the bass frequencies of recorded material. It can often be a headache to the hi-fi listener.

In reproducing sound it is important that the speed of both the recording and playback machines be held constant. Any speed variations will distort the recorded material.

One way to indicate speed variations or wow in the hi-fi system is to play back a constant frequency; for example, a test record or tape made for this purpose. A recorder may be checked by using the audio tone from WWV if a stable tone is not available from other sources.

For more accurate wow indications than are possible by ear, the system output is fed to a frequency-discriminating network and detector similar to that used in FM receivers. The detected difference between the highest and lowest frequencies can then be expressed as a percentage of the average speed.

However, a more simple check of wow can be made with a test recording, an audio oscillator and a scope. With the output of the pickup connected to the horizontal input, the output from the test recording can be seen. The audio oscillator is fed to the vertical input of the scope. Tuned to the same frequency as that from the test recording, the 1-to-1 Lissajous pattern will remain stationary. Any shift in frequency will make the pattern shift or change, depending on the amount of speed variation from the drive motor.

A regular or rhythmical pattern shift will indicate a drive-mechanism fault. Further examination of the worm, gear teeth or drive wheels may pinpoint what parts are causing the speed variation. Irregular speed variations can be caused by loose power connections or poor line-voltage regulation. Automatic appliances such as air conditioners, refrigerators and heating systems can also cause line-voltage variations.—*A. G. Sydnor*

By BASIL BARBEE

Test Set Aids Two-Way Radio Jobs

Rugged, portable test box measures current, voltage, field strength, provides speaker and audio test tone

TO PARAPHRASE THE OLD ADAGE ABOUT a radioman's sanity, "You don't *have* to use a test set to service two-way radio, but it helps." Most large communications equipment manufacturers make test sets for their equipment, and at least one makes a "universal" set supposed to fit them all, but I chose to build my own. Why?

1. It saved money. **2.** I incorporated the features I wanted, one or more of which were lacking in every test set I had seen. **3.** The case matches several other pieces of my equipment, and **4.** I like to design and build things.

After many years of servicing two-way equipment, I wanted a test set that would include:

1. A 50-μa meter for receiver and transmitter troubleshooting and alignment. **2.** A voltmeter for measuring plate voltages up to at least 700 volts. **3.** Means for measuring the final plate current of transmitters. **4.** A weatherproof loudspeaker with volume control. **5.** A switch for keying the transmitter during tests. **6.** A 1,000-cycle tone generator for modulation adjustments and general testing. **7.** A relative field strength meter for getting the utmost *radiated* output from a transmitter consistent with rated input. **8.** Means for connecting this apparatus to the equipment under test with the greatest ease and speed.

The finished product is shown with part of its case in the photo below. The antenna for the field-strength meter is supported by a fuse clip and a hole through the partition in the case lid.

The 50-μa meter, M, serves as the basic movement for all voltage and current measurements. Most two-way gear has metering sockets for a 50-μa meter for all necessary measurements.

The 20-megohm multiplier resistor, R9, consists of two 10-megohm precision resistors in series (for adequate voltage rating), and converts the basic 50-μa movement into a 1,000-volt, 20,000-ohms-per-volt voltmeter for plate-voltage measurements, either through banana jack J7 on the panel or through the function switch S4 and test cables. For plate-current measurement, R10 is switched in series with the meter to increase the total resistance to 20,000 ohms (or to convert it to a 1-volt voltmeter). Then it measures accurately the final plate current of transmitters such as Motorola and RCA. These have a built-in shunt across which 1 volt would correspond to a full-scale reading of 100, 250, or 500 ma, depending on the particular model of equipment under test. This information is given in the instruction books.

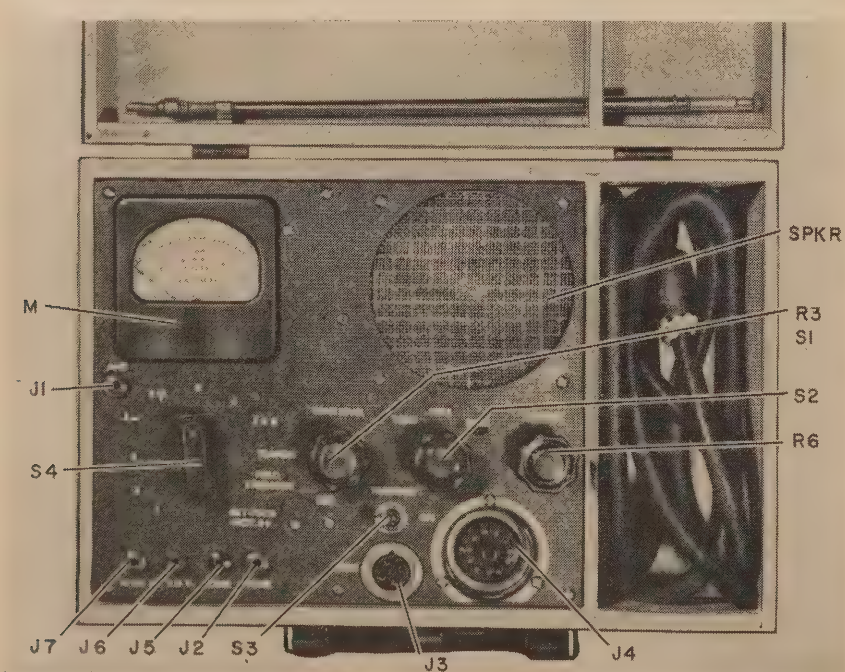
A 3-volt range is provided by multiplier R8, a 60,000-ohm precision resistor. This range is accessible only through banana jack J6. G-E equipment, for which the 3-volt range is required, has individual pin jacks for metering rather than a single multicontact socket.

The 1,000-volt scale is hand-drawn below the 50-μa scale already on the meter face. The 3-volt scale is drawn above the existing scale. Because of the nonlinearity of most 50-μa movements, a scale drawn for one make of meter does not necessarily work accurately with another make, so no paste-on scale is provided with this article.

Since weather conditions in the field are occasionally moist, every component of the test set should be as nearly weatherproof as possible. The speaker cone is particularly susceptible to moisture, so the speaker in the test set is a Quam heavy-duty unit with waterproof cone, like the ones used in drive-in theaters. A 20-ohm potentiometer, R6, serves as a volume control for the speaker.

An spst toggle switch (S3) is connected across the microphone push-to-talk circuit so that the transmitter may be left on while tuning, leaving both hands free. Of course, to avoid interference with other stations, the carrier should be kept off except when absolutely necessary.

The tone generator is powered by a self-contained 6-volt battery (Batt), and consists of a 2N169 Colpitts oscillator (Q1) at approximately 1,000 cycles, and a 2N107 voltage amplifier and buffer (Q2) direct-coupled to a pair of 2N438's or 2N448's in parallel (Q3 and Q4) as an emitter-follower. Oscillator coil L1 is one winding of a small surplus audio transformer which happened to have the right inductance. If the inductance is other than 0.37 henry, C1 and C2 may be changed to another value to put the frequency near 1,000 cycles. The only critical characteristic of L1 is



Cables tuck into compartment at right; antenna fits into lid.

its Q. If this is too low, it will prevent oscillation. You may want to select a value for R4 that gives least distortion.

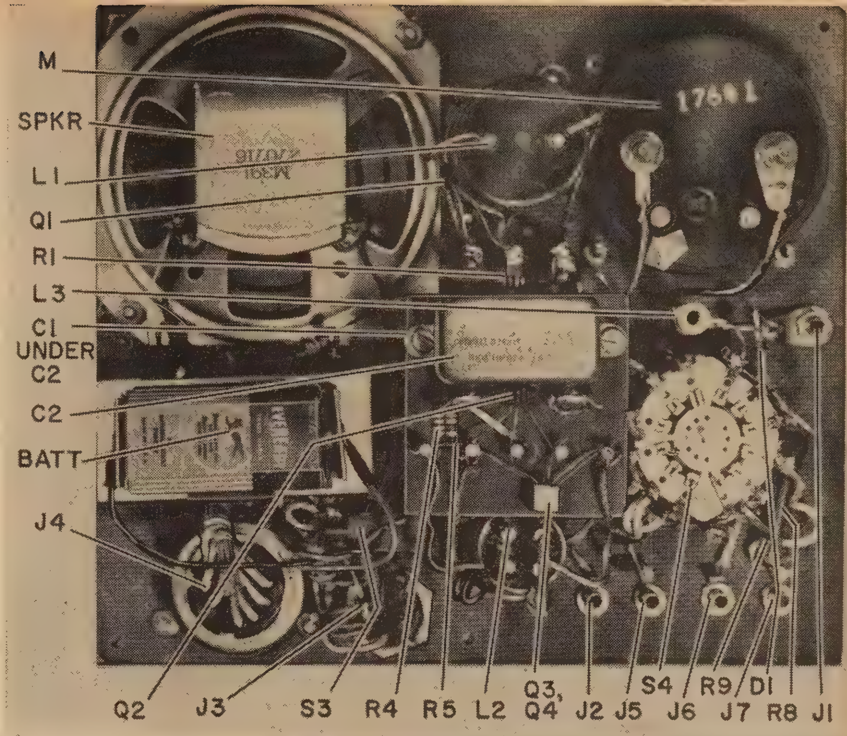
A drain of only 7 ma from the battery makes for long life. For dependability the battery should be replaced about once a year whether it needs it or not. While incorporated primarily for testing and adjusting audio circuits of FM transmitters, the tone generator is also used for modulating broadcast transmitters during frequency checks, for pair identification in cables, and wherever a fixed audio tone is useful. It puts 3.5 volts rms into 600 ohms with negligible distortion.

An rf choke (RFC), a 1N34 (D), a .01-μf capacitor (C5), and a 250,000-ohm rheostat (R7) convert the basic 50-μa meter into a relative field-strength meter. After a little experience, the meter permits a quick rough check of transmitter output without any direct connections. The meter tells you when you have adjusted the transmitter and antenna so that the most power is being radiated. If placed a few feet from the transmitting antenna, it does not detune the antenna.

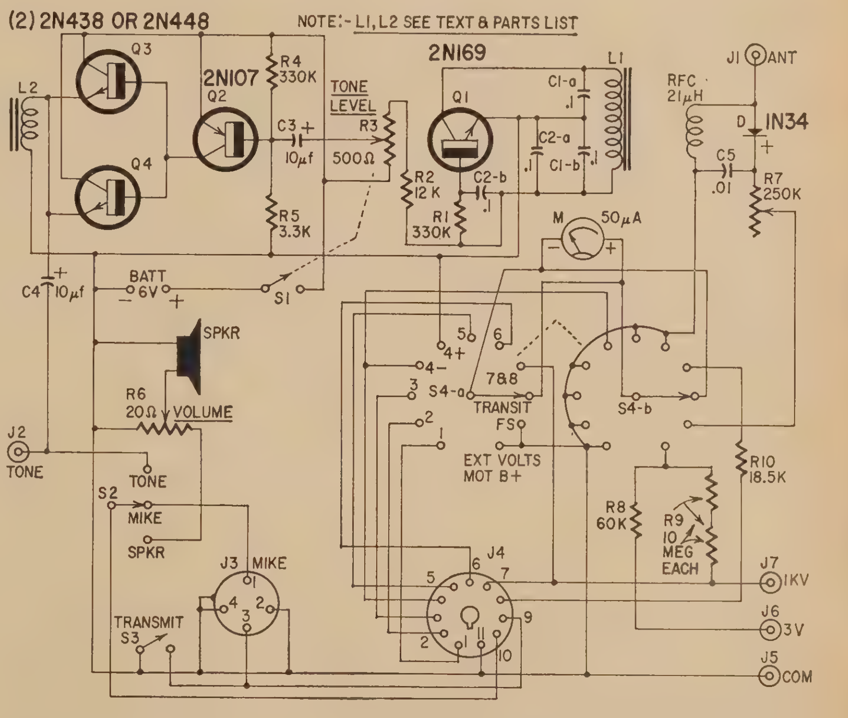
Half a pair of TV rabbit-ears fitted with a banana plug fits into J1 on the panel. Some adjustment of the sensitivity of the field-strength meter is possible by telescoping the rabbit-ear. For higher-powered rigs it may be necessary to turn down sensitivity control R7. (This control is not visible in the photographs; it was added after the pictures were made.) The peak-inverse voltage rating of the diode is not exceeded at any full-scale meter reading.

A 2-pole 11-position rotary switch, S4, connects the 50-μa meter to the various circuits to be metered, at the same time inserting the necessary multiplier resistors. The switch is ceramic-insulated to prevent leakage under humid conditions. For connection to the equipment under test, an 11-pin male receptacle, J4, is provided on the panel. All connections necessary for metering Motorola, RCA and similar equipment with metering sockets are made through J4. Since Motorola equipment predominates in this area, the pin connections were made to correspond with Motorola's metering sockets so that a straight-through cable may be used for connection. Adapter cables can be made up for other makes.

The first seven switch positions, except the fifth (marked "4+"), connect the negative side of the meter to pins 1 through 6 of the receptacle, while grounding the positive side, for reading grid currents of limiters and oscillators in receivers and the various stages of transmitters. The fourth position ("4−") reads discriminator output in receivers, while "4+" also reads discriminator output, but with reversed polarity. In



Internal view. Speaker cone is waterproofed, and many other parts are picked for humidity resistance.



C1, C2—dual 0.1-μf bathtub capacitors
C3, C4—10 μf, 10 v, electrolytic
C5—.01-μf, disc ceramic
D—1N34
J1, J2, J5, J6, J7—banana jacks
J3—4-contact mike receptacle (Amphenol 91-PC4F)
J4—11-pin plug (Amphenol 86-CP11 in 23-1S shell)
L1—0.37 henry inductance (small surplus transformer winding; not critical)
L2—1-henry choke (surplus; not critical)
M—50-μa meter, 1,500 ohms dc resistance (Simpson Model 27)
Q1—2N169
Q2—2N107
Q3, Q4—2N438 or 2N448
R1, R4—330,000 ohms
R2—12,000 ohms
R3—pot, 500 ohms, linear (Ohmite CU5011—with type CS-1 switch attached)
R5—3,300 ohms
R6—pot, 20 ohms, wirewound (Centralab WW-200)
R7—pot, 250,000 ohms, audio taper (Ohmite CA2541)
R8—60,000 ohms, 1%
R9—two 10-megohm, 1%, in series
R10—18,500 ohms, 1%
RFC—21-μh rf choke (Ohmite Z-28)
S1—spst switch (on R3)
S2—single pole, 3-position rotary (Centralab 1461 or equivalent)
S3—spst toggle switch
S4—double pole, 11-position rotary (Centralab 2513 or equivalent)
SPKR—4-inch weatherproof speaker (Quam 4A10T or equivalent)
Panel and case to suit
Miscellaneous hardware

Circuit of the test set.

the eighth position of S4, marked "7 & 8" on the panel, the meter with its 1-volt multiplier is connected across pins 7 and 8 of J4 for measuring final plate current in conjunction with the shunt provided in transmitters. Position 9 (TRANSIT) shorts the meter movement to damp vibrations while hauling. Position 10 grounds the negative side of the meter and connects the positive side to the field-strength meter components described previously. In position 11, the negative side of the meter is grounded and the positive side is connected through the 1,000-volt multiplier R9 to pin 7 of J4 for plate-voltage measurements.

J3 is a standard mobile microphone receptacle for plugging in a microphone to operate the transmitter from the trunk of the car or wherever it may be installed. J2 connects to the output of the tone generator for using this part of the instrument separately. J5 is a common terminal for all the circuits in the instrument. J6 connects to the meter when the switch is in EXTERNAL VOLTS position through a 60,000-ohm multiplier resistor R8. This connection provides a 3-volt range for testing G-E equipment, which has individual pinjacks for metering rather than a metering socket for all circuits, and requires a 3-volt range. Since J5, the common terminal, is not actually "grounded" to anything with no test cable in J4, voltages negative with respect to ground may be measured by reversing the leads to J5 and J6. J7 connects to the 1,000-volt multiplier for plate-voltage measurements on G-E and other equipment with no common metering socket.

S2 switches pin 10 of J4, the audio pin connecting with either receiver output or transmitter input to either the speaker, mike receptacle J3, or the tone generator.

The components are all assembled on an 8 x 9-inch Masonite panel, heavily lacquered on both sides after the decals are applied. The photograph shows parts placement. The panel is mounted in ¼-inch plywood carrying case 8 x 12¼ x 4⅛ inches inside. This leaves a 3 x 8-inch compartment for test cables. The case is finished inside and out with several coats of Duco enamel for protection against moisture and rough handling. All eight corners are fitted with brass protectors. The cover, 1 inch deep inside to provide clearance for the control knobs, is attached with half-hinges for ready removal. It is kept closed by a latch from war-surplus equipment. A carrying handle removed from the counter tube tester completes the hardware, all of which except the corner guards is mounted with 6-32 screws and nuts. The nuts are recessed into the wood inside and soldered to the screws to prevent loosening. END

When you have to align (and don't unless you have to!) this one-at-a-time approach is pretty simple

ALIGNING TV I.F.'S

ALIGNING VIDEO I.F.'S AND TUNERS IN TV sets can be a touchy problem. Far too many times we have to say, "It's a beautiful curve. Just like the book. Only one little trouble: it won't work!" Let's take this problem one step at a time and see if we can't make some sense out of it.

Last month ("In and Around the Video I.F.") we saw how to set up and calibrate a signal generator for video alignment. This time, let's get to work and actually walk through a video alignment. First, let's be sure we know why and when to align.

Why do we align, anyhow? To make the stages pass the wide band of signal frequencies we need to get a complete TV signal, both picture and sound. They're 4.5 mc apart, so this takes some doing. The natural response of a tuned circuit would be far too narrow unless we did something to make it broader. Unfortunately, when we broaden it, we lose gain (Fig. 1). So we have to add more stages to get back the gain.

The old sets used *overcoupled* transformers. Hard to align, and not too much bandwidth either. Now we use *stagger-tuned* circuits. In these, each circuit peaks at a different frequency, and "holds up the curve." Each circuit has a peaked response at a certain frequency. So, this raises the overall curve *around that frequency*. (One other advantage: since no two circuits are peaked at the same frequency, we don't have oscillation in the i.f. strip.)

The response curve actually means "amplitude vs frequency." It tells us what the output of the i.f. is at any given frequency within the bandpass limits. Fig. 2 shows a typical i.f. response. Note the position of the frequencies on the curve, and this basic fact: here, we work in *percentages*.

We use an odd little system in transmitting TV signals: *vestigial sideband*. That means that we modulate the picture carrier with the signal, then chop off almost all of one sideband (modulation frequencies plus or minus the carrier frequency) because the information in one sideband is the same as that in the other. Our i.f. response must match this characteristic. So, we put the picture carrier part way up one side, so that the sideband that is transmitted falls on the high-gain part of the curve and gets amplified. The partial (vestigial) sideband falls on the sloping-down part, but we don't need it anyhow.

The sound signal is 4.5 mc away, and, since this is FM, we don't need a lot of amplitude. We can get that back later on, by amplifying it some more. If we let the sound carrier get too big going through the video i.f., it interferes with the picture signal. So, we keep it down on one side of the curve until we get ready to use it.

When to align

A lot of sets are realigned when they really don't need it. Far too many of us decide that a set needs alignment and start twisting screws and slugs. This leads only to trouble! Two axioms in all alignment work: First, be sure that the set is in good condition *before* you start any alignment. Second, be sure that it

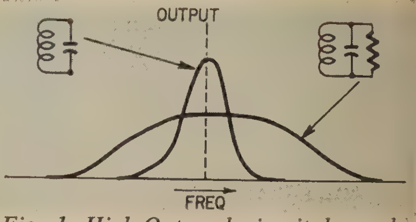


Fig. 1—High-Q tuned circuit has relatively sharp, peaked response. Lowering circuit Q with shunt resistor broadens and flattens response.

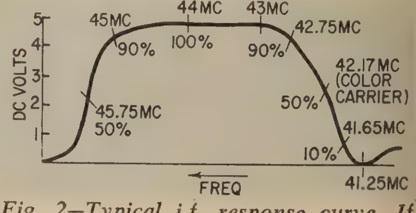


Fig. 2—Typical i.f. response curve. If percentages of full amplitude are correct, shape of curve will be correct. Actual height of curve unimportant, but frequencies must fall at specified levels.

needs it! To find this out, you must hook up the proper test equipment; you *can't* judge this "by eyeball" or even on a test pattern! No one can.

Because of the design and construction of TV i.f. amplifier stages, you'll find very little actual drift. If you'll set up your alignment equipment and test a good-grade TV set about 8–10 years old—one that you know hasn't been touched, you'll be surprised how close it will be to perfect align-

By JACK DARR
SERVICE EDITOR

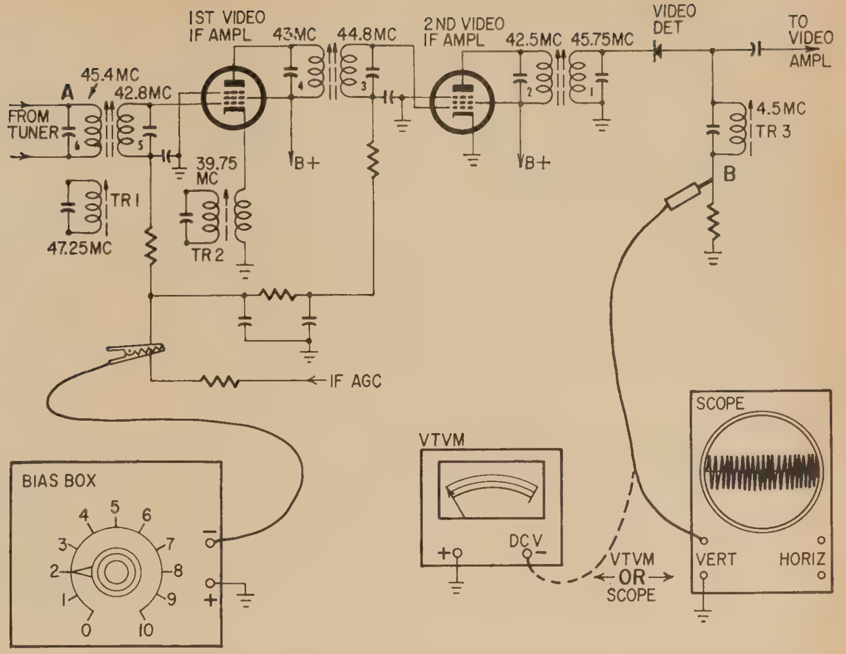


Fig. 3—Generalized video i.f. strip shows usual tuned circuits—both "trap" and "pass" types—that have to be adjusted exactly to the indicated frequencies. To keep agc from compensating for changes in signal level due to alignment operation, bias box is used to clamp bias.

ment! *The main cause of misalignment is "screwdriver drift"!*

To find out whether a set really needs alignment, test it! Connect the alignment equipment and run a sweep curve, check marker positions, etc. Did you know that this kind of test setup is also a very useful way to check for i.f. gain? Just try replacing a tube in the i.f. under these conditions. If the curve rises, very perceptibly, the old tube was weak.

After a little practice, we'll be able to tell by the setting on our signal generator output just about how well the circuit is working. We used to do this with radios, and we can do it just as easily with TV sets.

Aligning stagger-tuned i.f.'s

The first step, as in *all* alignment, is to get the set working. Check all tubes, voltages, etc., and be sure that you can get at least part of a picture or sound through it. Always remember this: no TV set ever suddenly jumped out of alignment! If it was working and quit, some part has failed. This will not change the alignment, unless the part happens to be an i.f. transformer!

Replacing an i.f. or tuner tube may throw alignment off very slightly, but it will never change the alignment so far that you can't get picture and sound through it. (Try it and see!) So, make this a firm rule: *Never* touch any of the alignment adjustments until you have found and fixed all the other troubles—even then, not until you have a full set of alignment test equipment connected so you can see just what you're doing.

Let's see *how* to do it. Set's working, but it "just doesn't look right." Streaking, ringing, echoes after black objects, and so on, or maybe the sound won't come in where the best picture is. In color TV sets, maybe we get a good black-and-white picture but can't get the color to stay in, and so on. These can all be signs of misalignment. (Of course, they can be signs of other troubles too, but you fixed them first, didn't you? If you didn't, go to it now!)

To align a stagger-tuned i.f., we need an accurate rf signal generator, a bias box and a vtvm. The bias box is the first thing we set up. A fixed bias "locks" the gain of the i.f. stages so that it won't change with changes in signal. A shift in bias could obscure the gain changes we're looking for. Fig. 3 shows a typical i.f. stage. Connect the negative terminal of the bias box to the i.f. agc return as shown. The alignment instructions will tell you about how much voltage to start with.

We feed the signal generator into the input of the i.f., at point A. You should couple very loosely here. Often, just clipping the signal generator lead to an insulated wire or to the body of a resistor near the stage you're working on is enough. We connect a dc vtvm across the video detector load resistor, at point B.

What we're going to do is feed single signals into the input, and peak each of the tuned circuits for maximum response on the vtvm. Ordinarily, we'll get a negative-going dc voltage at the video detector output with an *increase* in signal strength. But check the polarity of the diode.

To be sure that you're actually getting a signal through the circuit, set up the generator on any of the alignment frequencies given in the alignment instructions, and see if this gives us a reading on the meter.

Turn the rf output up and down; if the dc voltage "follows," we're OK so far. If it doesn't, try reducing the negative bias from the bias box slightly. You may have the i.f. stages cut off.

Now, we're ready to go. Best way, in most sets, is to begin at the last i.f. and work toward the input. In this case, we'd set up for a 45.75-mc signal and align the secondary of the output i.f. transformer for a peak on the meter. Keep the reading as low as possible. If your meter reading goes too high, it'll be hard to find the exact peak. Keep it down to 1–2 volts by cutting down the rf signal input. Adjust each of the tuned circuits in turn. Here, we have nine of them. Six are "gain" circuits, adjusted for *maximum* response. The rest are *traps*.

Traps are resonant circuits included to take out frequencies we *don't* want (the sound from the channel above, and so on). So we adjust these to a *minimum*. An "absorption trap" takes out undesired signals by furnishing a very low-impedance path to ground. To set a trap properly (and this will always be noted in the alignment instructions), feed in a large rf signal, get a reading on the meter, then tune the trap for the *lowest* possible reading.

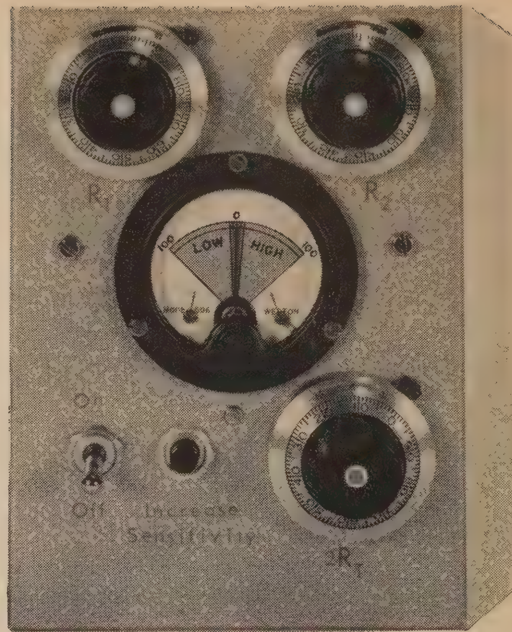
The reading may not go to zero, but get it as low as you can. Tune for maximum dip; then increase the output of the signal generator and recheck for minimum.

The scope as output indicator

You can use the scope in the same way as the vtvm, although the meter is a wee bit easier to read for very fine adjustments. Simply use a modulated rf signal input and tune each circuit for maximum *height* of the audio pattern on the screen. You can use this for setting traps, too. Just tune for minimum pattern height.

With this process finished, you ought to get a good picture and sound. Take the alignment equipment off and check the set on the air. END

Parallel-R Calculator



Need an odd resistance value?
This instrument makes the job easy.

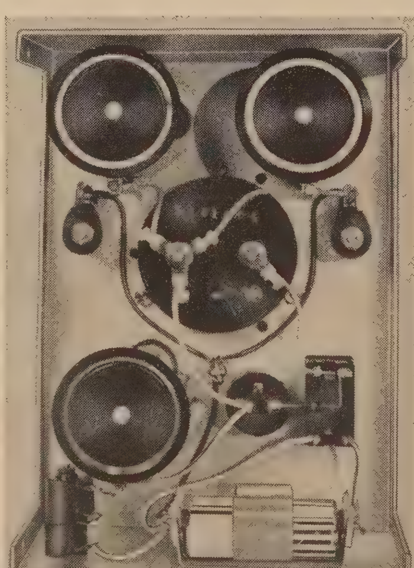
By MELVIN S. LIEBERMAN

IF YOU NEED ODD RESISTANCE VALUES frequently, this nomogram and instrument (Fig. 1 and 2) can save you considerable time. They will also solve parallel-inductance and series-capacitance problems. The nomogram is useful for determining quickly the power shared by resistors in parallel and can be used independently of this instrument. It can be used similarly for series-capacitor voltages.

Construction of the calculator is simple, and you need not follow the layout I used. [The original high-precision parts give 1% or better accuracy, but they're expensive. Ordinary wirewound pots and 1% resistors will do for everyday bench use, depending on the accuracy required for the particular application.—*Editor*]

When it is completed, set potentiometers R1, R2 and $2R_T$ for zero resistance. Put the dials on at a setting of 100 (not zero), so the dial range is from 100 to 1,100. R1, R2 and $2R_T$ are connected so that clockwise rotation (increasing dial number) increases resistance. The limit resistors R3, R4 and R5 are one-tenth the value of potentiometers R1, R2 and $2R_T$ (Fig. 2). This limits the maximum current through the meter and makes a dial-reading change of 10 to 1 coincide with a resistance change of 10 to 1. Although the unit can be used for any application where the basic formula is $1/X_T = 1/X1 + 1/X2$ the three dials are labeled R1, R2 and $2R_T$ because the instrument is used most frequently for parallel resistances.

The circuit has two arms. One is a simple series circuit, the other series-parallel. The two arms have the meter common to them. The batteries are connected so that current from these two arms flows through the meter in opposite directions. The combined total resistance of the series-parallel arms, R1, R3 and R2, R4 is half of arm $2R_T$, R5. Batt 2 has twice the voltage of Batt 1, so current flow in these two arms will be equal for equal dial settings. This arrangement allows all of $2R_T$ to be used instead of half, as would have been the case were Batt 2 equal to Batt 1 and the total resistances of the two arms equal. With this circuit, dial $2R_T$ will read twice the actual R_T value, so it is labeled $2R_T$. This permits a more accurate reading, since any dial reading will be divided by 2.



Inside the case. Parts placement is not critical.

I decided to use a 100–0–100-μa movement, because it would give a fine null reading. Since the power requirements are very small, a penlight cell is used. With 1.5 volts and 100 μa the total maximum resultant resistance in arms, R1, R3 and R2, R4 must be 15,000 ohms (1.5v/.0001a = 15,000 ohms). Therefore each arm must be 30,000 ohms. Since a 15,000-ohm potentiometer of this type was not available, a 30,000-ohm pot was used for $2R_T$. With double the resistance being used, it was necessary to double the voltage to provide equal currents in both arms for equal settings.

The total resistances of the two arms is such that, with the voltages used, the currents for maximum and minimum potentiometer settings are 83 μa and 1 ma. A normally closed pushbutton (S2) connects the shunt R6 across the meter. This shunt protects the meter for any settings of R1, R2 and $2R_T$ which will cause the greatest unbalanced current flow.

To check for accuracy, I set dial R1 to 1,100, and dial R2 to all the EIA values in turn from 110 through 1,000 ohms. The measured values were compared with the computed values as a percentage error. This instrument's accuracy is good enough to allow it to be used as a companion for a 1% Wheatstone or other type of bridge, when it is built with the parts shown in the parts list.

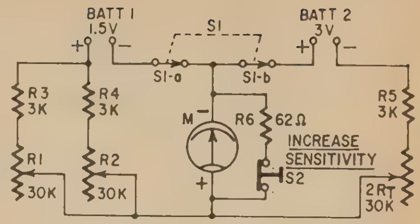
The instrument is simple to use. If you need to find a parallel value (two known resistors in parallel), set R1 to one value and R2 to the other. Adjust

$2R_T$ for a null (zero reading). Press the INCREASE SENSITIVITY switch (S2) and finish the $2R_T$ dial null setting. The $2R_T$ dial is exactly what it is labeled: *twice* the resultant resistance; therefore, divide its reading by 2. The answer is the resultant resistance.

Should you need some odd value of resistance (a more common case), set the $2R_T$ dial to *twice* this desired value. Now there will be many possible combinations of dials R1 and R2 which will give a null and, therefore, satisfy the requirement. Set either R1 or R2 to some convenient value and determine the null with the other dial to satisfy the requirement.

The R1, R2 and $2R_T$ dials may be divided or multiplied by multiples of 10, as long as all three dials are treated alike. This instrument may be used for any number of parallel resistors by computing values two at a time. The meter scale has LOW on the left side and HIGH on the right side of "0". This indicates that the setting of dial $2R_T$ is low or high when the meter pointer is to that side of zero (center).

The use of the percent-total-watts nomogram (Fig. 2) can best be illustrated by an example. Suppose you need a 3-watt resistor of some specific value. Many combinations of resistors will produce that value, but only one will share the wattage in the correct proportion. For a 3-watt resistor, the power distribution will best be 1 and 2 watts, or 33⅓ % and 66⅔ % of the total. On the nomogram, draw a single line from zero to the 66⅔ %, 33⅓ % point. On the instrument, choose a combination of R1 and R2 that satisfies R_T (remember that the dial on the instrument will be $2R_T$) and whose abscissa and ordinate intersect this 66⅔ %, 33⅓ % line. The lowest value of R1, R2 will dissipate the highest wattage, and the largest value of R1, R2 will dissipate the lowest wattage. END

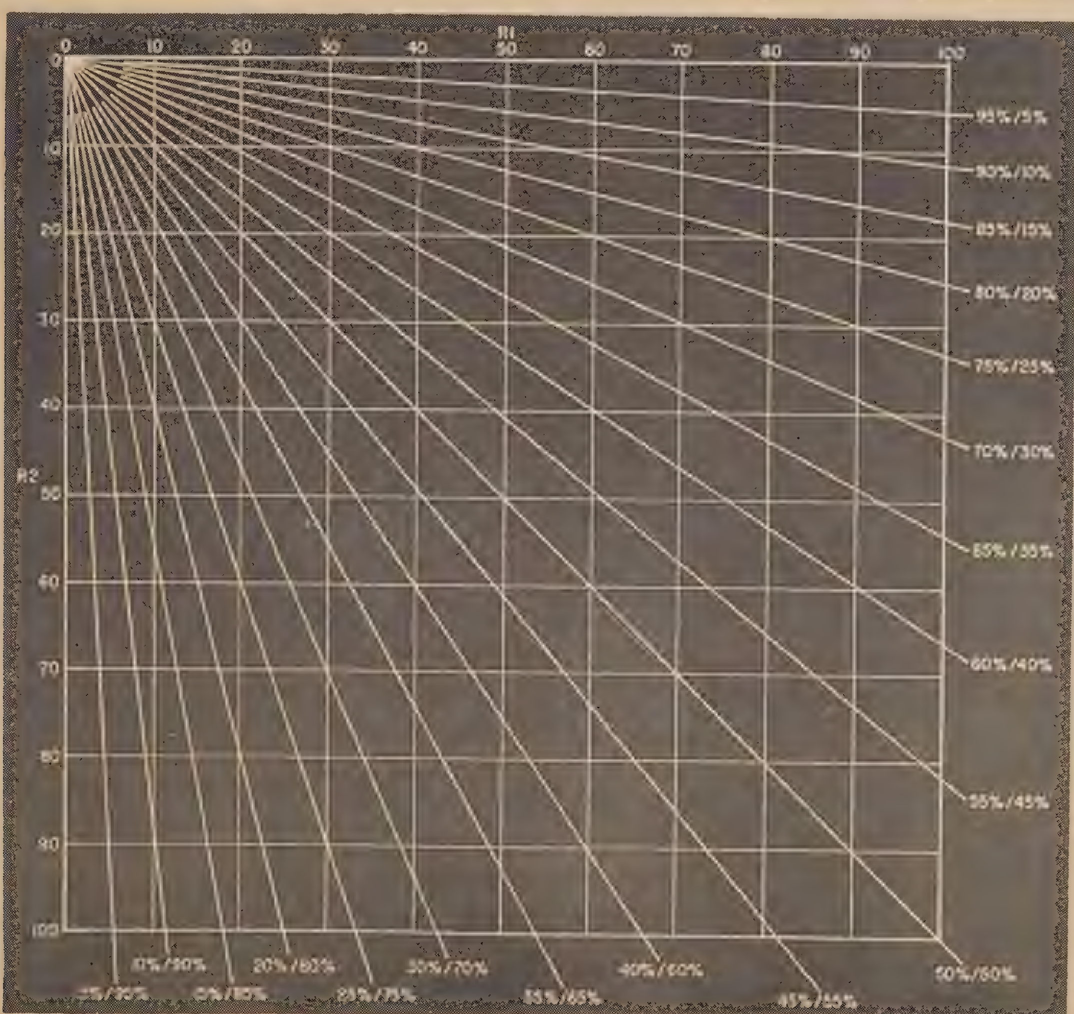


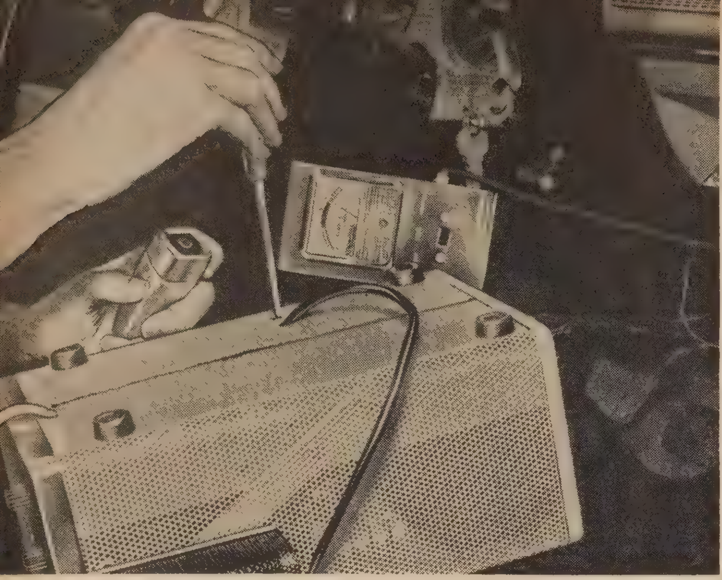
R1, R2, 2RT—Pots, 30,000 ohm, 3%, 10-turn, linearity 0.1% (Spectrol 860, Clarostat 59-14JA, Borg 2201B, IRC HD-150 or equivalent)
R3, R4, R5—3,000 ohms, 0.1% (Eastern Precision Resistor Co. N-110E or equivalent). 1% units usable with slight loss of accuracy (IRC WW4J, Daven 1174, RPC type AAF)
R6—62 ohms, ½-watt, 5 or 10%
S1—dpst toggle switch
S2—Pushbutton, normally closed (Grayhill 2202 or equivalent)
BATT 1—1.5 volt dry cell
BATT 2—two 1.5 volt dry cells in series
M—100–0–100-μa meter (Weston 506 or equivalent)
Case—2-section, 7 x 5 x 3 in. (Bud Minibox CU-3008A or equivalent)
Dials—3 Beckman Duodials (model RB or equivalent). Substituted dials must have at least 11 turns—10-turn dials will not do
Battery holder
Miscellaneous hardware

Fig. 1—Calculator circuit.

Fig. 2—Nomogram gives percent of total power dissipated in each resistor of parallel pair. Range can be extended by multiplying both scales by multiple of 10. Nomogram can be used independently, without calculator.

Suppose you have two paralleled resistors, R1 and R2, 300 ohms and 900 ohms, respectively. Mark off R1 at 30 on the horizontal (R1) scale, and R2 at 90 on the vertical (R2) scale. Now find the point where the 30 and 90 lines intersect. Lay a straightedge between that point and the origin 0 (upper left corner). The line drawn along the straightedge will fall on or along one of the percent lines, and you can read off the percent of total power dissipated by each resistor.
Remember that the *higher* percentage applies to the *lower* resistance value, and vice-versa.





"SECOND PHONE"

Ticket to CB Service Profits!

For much CB work, you must hold a Second-Class FCC Radiotelephone License

By JIM KYLE, KEG-3382

IN THE NOVEMBER 1963 ISSUE OF RADIO-ELECTRONICS, we said that, contrary to most peoples' belief, you could do *almost* anything to a CB transceiver without an FCC Second-Class Radiotelephone license ("Servicing CB Transceivers," p. 46). But that still isn't *everything*. You can't make any adjustments or repairs that might affect the transmitting frequency, nor can you make on-the-air checks or tune-ups without that ticket. Since such jobs do come up, you are still somewhat handicapped until you get your license.

The first step is to write the FCC office nearest to you (a list of field offices accompanies this article) and ask them for the latest schedule of examination dates and a set of application forms for the Commercial Radiotelephone Operator license.

The second step is to do a little studying. If you happen to be a ham operator already, you'll have no trouble with the theory portion of the Second Class examination. However, the questions dealing with rules and procedures may give you some static.

The examination for Second-Class licensees (which is all you need) consists of three separate tests: Element I, Element II and Element III. Each element contains enough questions to give you a fair test; almost all of the them are multiple-choice, but a few require you to draw *or correct* typical schematics.

Element I, "Basic Law," is required of *all* commercial licensees. It deals with such things as distress messages and secrecy of communications.

Element II, "Basic Operating Practice," is the one most likely to cause you difficulties since, as a service technician, it falls completely outside your experience. Typical questions might include such items as "Which of the following stations may be operated by the holder of a radiotelephone Third-Class operator permit?: **1.** Standard broadcast. **2.** TV. **3.** Relay. **4.** FM. **5.** None of these." (The correct answer is 3.) Or "Which of the following is the proper meaning of the word 'Roger'?: **1.** My transmission is ended and I expect a response from you. **2.** This conversation is ended and no response is expected. **3.** I have received all of your last transmission. **4.** Your last message received, understood, and will be complied with. **5.** None of these." (Again, the correct answer is 3.)

The best way to prepare for these questions is memorization! The study guide published by the Federal Government is available from the Superintendent of Documents, Washington 25, D.C. Even better for study purposes are the "Q&A" books published by Sams and Rider; one of these is in the library of almost every city. The "Q&A" books include rather complete discussions of the various questions.

Element III is the theory portion of the test.

It consists of 100 questions. Usually the last five consist of schematics which either you must draw or which have been drawn but contain errors and must be corrected.

A few typical Element III questions are: "The heat dissipation in watts of a 20-ohm resistor carrying ½ ampere of current is: **1.** ½ watt. **2.** 5 watts. **3.** 1 watt. **4.** 20 watts. **5.** None of these." (proper answer—2.) Or the much more complicated "Operation on a frequency lower than the resonant frequency of an available Marconi antenna may be accomplished by: **1.** Adding inductance in series with the antenna. **2.** Adding capacitance in series with the antenna. **3.** Cannot be done. **4.** Adding capacitance in parallel with the antenna. **5.** Adding inductance in parallel with the antenna." (proper answer—1.)

The third step in getting the license, of course, is to take the exam. That schedule you wrote for will show the dates, times and places of examinations for the coming 3 months or so. Pick your time and place and try to get there early. You'll need to take along a pencil and pen, and a check or money order for $4, payable to "Federal Communications Commission."

Fill out your application forms in advance, and when you get to the examination point give them to the examiner. He will give you the packet of exam papers, and from there it's up to you.

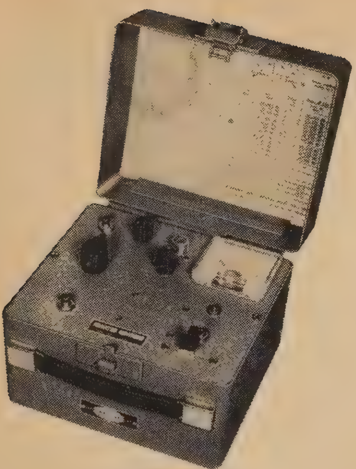
Plan about 3 hours—1 hour per element. If you've studied well, you won't need all this time—but frequently it may even take a little longer.

Tips on taking the exam

My standard procedure when taking an FCC exam is first to scan through the exam paper, then calculate how many questions I can *fail* and still pass. Since a 75% score is the dividing line, this means I can miss 12 questions on a 50-question exam or 24 out of 100.

Then I go through again, answering only those questions I am *sure* of. This done, I count the unanswered ones.

If there are fewer left unanswered than the number I can safely miss, I feel "home safe" and go back a third time, answering with the first guess (amazingly, this is often the right answer—the subconscious frequently supplies the answer though the conscious mind refuses



This International Crystals CB frequency meter is well suited to CB work. But you mustn't act on any faults it shows unless you have a license.

to recognize it).

If, however, I still have some to do I go back and think—dig into the memory —work at it. A typical example was a field-strength problem on the First-Class exam. I knew I knew how to work it but, because of "exam jitters," couldn't remember the right way. I worked the problem five times in five different ways. The fifth time, my answer was one of the five printed on the answer sheet so I turned it in. I still don't know if it was right or not—but that question marked the magic number on that test, and I passed the exam.

Once you've taken the test, you have another 2 weeks or so to wait. If you passed everything, your license will come in the mail. If you passed Elements I and II but failed Element III, you'll get a Third-Class license; this means the next time you try you won't have to take I and II over again.

So now (let's hope) you have your license. What do you do with it?

Oscillator checks

One point made in the earlier article is that it is perfectly all right to make voltage measurements and do other troubleshooting on a CB transmitter oscillator, but if that didn't help, you could not adjust frequency or do any tuning that might affect frequency.

Now—you have your Second-Class ticket. Suppose the complaint is low output but the oscillator voltages are all normal. Try retuning the oscillator plate circuit to get the maximum negative voltage at the grid of the following stage (buffer or final). In some circuits, tuning the output circuit will "pull" the oscillator frequency itself, perhaps causing off-frequency operation. So be sure to measure the frequency after the adjustment to make sure it hasn't wandered beyond tolerance. For this, you'll need a frequency meter.

The International Crystal model C-12B, made especially for CB service, is one of the easiest to use. Also suitable are the Lampkin model MCM, and various other meters made by DuMont, Eltec Laboratories and Gertsch. The BC-221 is *not* accurate enough without a complex measuring technique.

Specialized equipment like this is very easy to use. For example, to measure frequency with C-12B, connect the meter to the transceiver, set the rotary switch on the meter to the channel you want to measure, key the transmitter on and read the deviation in cycles per second from the meter scale.

Air checks

One further use you'll have for your Second-Class license is actual transmitting tests with an antenna. Not all antennas (not many, even) present the pure resistive impedance of a dummy load. So to give a more valid indication of transmitter performance, it is wise to check operation with the transceiver connected to the antenna with which it will be used. Here, an SWR (standing-wave ratio) meter is useful. These are often combined with power meters, and the two functions are both very useful in adjusting the transmitter output network and the antenna matching network (if there is one) for maximum power transfer.

But—you can make such tests legally only with that Second-Class license! With this article is a list of FCC Field Offices to which you can write for forms. Why put it off? END

FCC FIELD OFFICES

Address correspondence to "*Engineer in Charge, Federal Communications Commission,*" and follow that with the appropriate address from the list below. Choose the one nearest you.

ALASKA: Room 53, US Post Office Building, Anchorage

CALIFORNIA: Mez 50, 849 S. Broadway, Los Angeles
3238 Customhouse, 555 Battery St., San Francisco

COLORADO: 521 New Customhouse, 19 St., Denver

DISTRICT OF COLUMBIA: 718 Jackson Place, NW, Washington

FLORIDA: 312 Federal Building, Miami

GEORGIA: 718 Atlanta National Building, Atlanta

HAWAII: 502 US Customhouse, Court House & Post Office, Honolulu

ILLINOIS: 826 US Court House, 219 S. Clark, Chicago

LOUISIANA: 608 Federal Office Building, New Orleans

MARYLAND: 400 McCawley Bldg., Baltimore

MASSACHUSETTS: 1600 Customhouse, Boston

MICHIGAN: 1029 Federal Building, Detroit

MINNESOTA: 208 Federal Courts Building, 6 & Market Sts., St. Paul

MISSOURI: 3100 Federal Office Building, 911 Walnut St., Kansas City

NEW YORK: 328 Post Office Building, Ellicott & Swan Sts., Buffalo
Federal Building, 641 Washington St., New York City

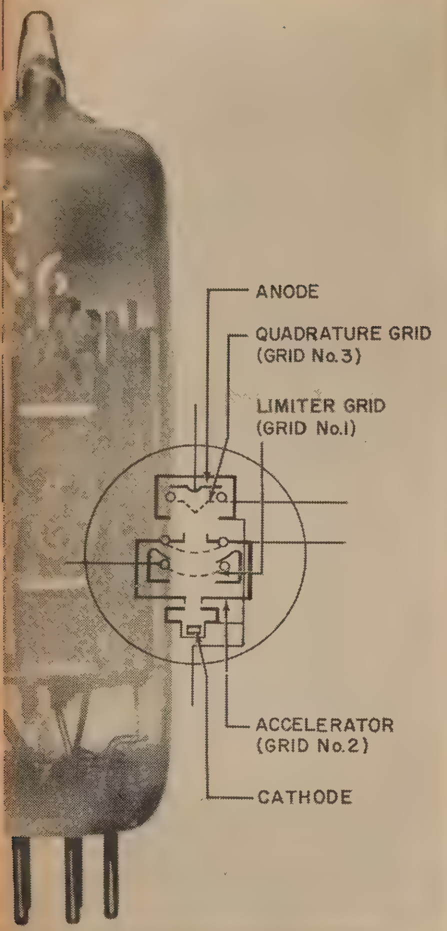
PENNSYLVANIA: 1005 New US Customhouse, 2 & Chestnut Sts., Philadelphia

PUERTO RICO: 322-323 Federal Building, PO Box 2987, San Juan

TEXAS: 401 State General Life Insurance Building, 708 Jackson St., Dallas; 324 US Appraisers Stores Building, 7300 Wingate St., Houston

VIRGINIA: 402 Federal Building, Norfolk

WASHINGTON: 802 Federal Office Building, 1st Ave. & Marian, Seattle



VERSATILE 6BN6

You may have to think hard to find something you *can't* do with this tube!

By LEO G. SANDS

THE 6BN6 GATED-BEAM TUBE IS ONE OF the most interesting available to the experimenter. Many TV sets and FM tuners use it, as does some mobile radio equipment. But few who service equipment using this unique tube have given it much thought.

Its schematic symbol is the same as that of a pentode: three grids. Like a pentode, the 6BN6 control grid is nearest the cathode. But what would ordinarily be a screen grid is an *accelerator* grid. And in lieu of the suppressor grid, the 6BN6 has a second control grid known as a *quadrature* grid. Let's call these grids 1, 2 and 3.

In a pentode, grid 3 has very little effect on plate current and is usually connected to cathode or to ground. But in the 6BN6, grid 3 has about the same effect on plate current as grid 1 (control grid). When grid 1 or 3 is made only slightly positive, plate current will reach maximum. Making these grids more positive will not cause plate current to rise any higher. Plate current can be cut off completely by making either grid 1 or 3 slightly negative. Hence the tube can be used as either an AND or an OR gate.

Because of its unusually sharp cutoff charactersitics and extremely high transconductance, the 6BN6 has many applications besides the one for which it was specifically

FM limiter

The 6BN6 tube is used in FM tuners and in many TV receivers as a combination FM discriminator and limiter. It is also used as a limiter only, when followed by a discriminator or ratio detector (Fig. 1).

The i.f. signal fed to grid 1 alternately drives plate current to maximum and to cutoff. Hence, amplitude modulation and noise pulses are erased and the amplitude of the output signal cannot exceed a specific level regardless of how hard the grid is driven.

A single fixed resistor can be used in the cathode circuit to obtain about 1 volt negative bias for both grids 1 and 3. But since the bias is critical, a variable cathode resistor

CONDENSED SPECIFICATIONS	
Heater voltage	6.3
Heater current	0.3 amp
Maximum plate voltage	330
Maximum grid 1 voltage	60 peak
Maximum grid 2 voltage	110 peak
Maximum grid 3 voltage	110 peak
Maximum cathode current	13 ma

The 3BN6, 4BN6 and 12BN6 are identical to the 6BN6 except for heater rating.

(R2) and limiting resistor (R1), shown in the diagram, is recommended.

The greatest advantage of the 6BN6 as a limiter over conventional two-stage limiters is its short time constant. In ordinary limiters the grid leak and capacitor lengthen the time constant. They are not required with a 6BN6. Hence the gated-beam limiter clips noise impulses instantaneously and is said to produce far better noise immunity than any other FM limiter.

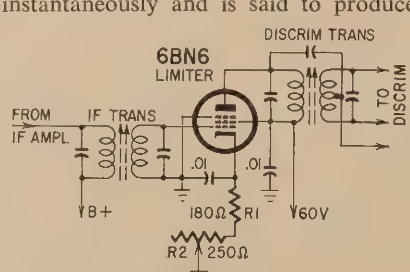


Fig. 1—The 6BN6 as a limiter for FM tuners. Bias should be adjusted for optimum performance with R2.

FM discriminator/limiter

A single 6BN6 can do the work of two pentodes, two diodes and a triode, customarily used in FM receivers as cascade limiter, Foster-Seeley discriminator and audio amplifier. The gated-beam discriminator is claimed by many government and industrial experts to be superior to any other type.

In the circuit of Fig. 2, all these functions are performed by a single 6BN6. Bias is adjustable as before so that the tube can be set to the optimum operating point.

Grid 1 is driven by the i.f. signal from the preceding i.f. amplifier. Resistor R3 broadens the selectivity of the input i.f. transformer.

Grid 3 is excited by the same signal because of space-charge coupling. This causes the signal voltage to develop in the resonant circuit, L1–C1, which is shielded from the input i.f. transformer. When the grid 1 signal is at a level of about 2 volts rms, the signal at grid 3 has a level of about 4 volts rms. The signal at grid 1 leads the signal at grid 3 by 90° when L1–C1 is tuned to the frequency of the incoming signal.

When the incoming signal changes in frequency, with frequency modulation, the phase relationship between the signals at the two control grids changes.

The incoming i.f. signal causes grid 1 to open and close its gate. Plate current can flow only when the gate formed by grid 3 is open. Because of the high Q of L1–C1, the grid 3 gate opens and

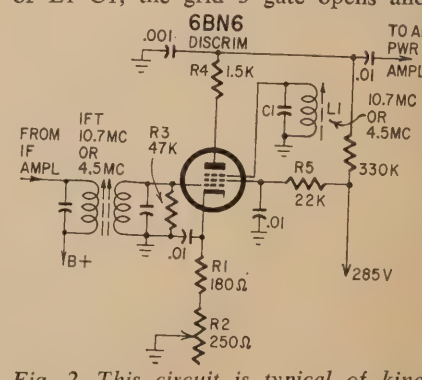


Fig. 2—This circuit is typical of kind of FM-limiter-detector-rolled-into-one found in many TV sets and some FM tuners.

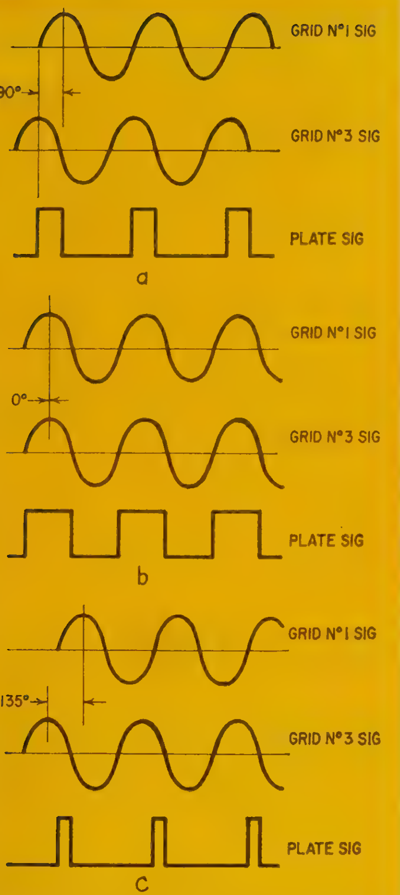


Fig. 3—Theory: tube conducts only when both grids 1 and 3 are positive. Fig. 3-a shows grid and plate waveshapes with unmodulated carrier at grid 1. In 3-b, instantaneous frequency is lower than center carrier frequency, and in 3-c, higher.

closes at regular intervals. But, as the incoming i.f. signal changes in frequency, the times at which the grid 1 gate opens and closes vary with respect to the opening and closing of the grid 3 gate.

Hence the plate current consists of a series of pulses of varying width as shown in Fig. 3. The average plate current therefore varies with the modulating frequency. The resulting audio signal is developed across C2, which is fed through R4, a linearizing resistor.

With a 2-volt rms i.f. input signal, the peak audio output voltage is around 16 when a fully modulated FM signal is received and the plate supply is about 270–300 volts.

Mobile radio use

The 6BN6 is also used in mobile radio communications receivers as a combined FM discriminator/limiter. Fig. 4 shows a circuit in a typical receiver.

Note that the cathode is grounded. Under no-signal conditions, grids 1 and 3 are at zero potential. When a signal is present (even noise), bias for grid 1 is developed across R1 and R2. The test point (TP) is used for receiver alignment purposes.

Since this discriminator operates at 1650 kc instead of 10.7 or 4.5 mc as in FM tuners and TV receivers, respectively, a small capacitor, C2, is used to obtain sufficient signal at grid 3.

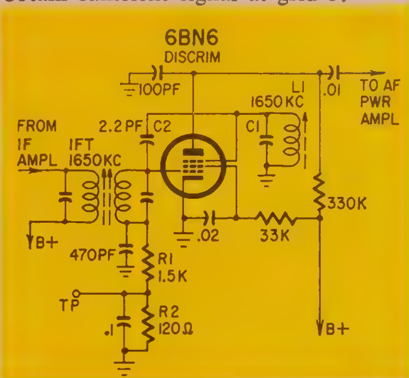


Fig. 4—Special form of gated-beam discriminator for narrow-band FM service.

AM detector

The 6BN6 will also work as an AM detector and audio amplifier with the circuit shown in Fig. 5. I devised and tried out this circuit, found the results very satisfactory.

Grid 1 and the cathode act as a diode detector electron-coupled to the rest of the tube, which functions as an audio amplifier. Avc voltage is developed across R1. Bias voltage is obtained at the junction of R2 and R3. Potentiometer R4 can be used to adjust avc for delay. The operating point of grid 3 is adjusted with R5 to the point where optimum output with minimum distortion is obtained. Output is sufficient to drive a beam power output tube without an intermediate af amplifier stage.

Combination FM/AM detector

AM ham receivers can be converted to receive both narrow-band FM and AM signals by replacing the diode detector and first af amplifier triode with a 6BN6. A practical circuit is shown in Fig. 6. When S1 is set to the FM position, the avc voltage is grounded. In the AM position, the quadrature tuning circuit (C1–L1) is grounded out. C1–L1 may be any convenient network operating at 455 kc. You can use a 455-kc i.f. trap or half of a 455-kc i.f. transformer.

Squelch circuit

The 6BN6 can also be used as a squelch-controlled af amplifier. A possible circuit is shown in Fig. 7. Here the af signal from the detector is fed to grid 3. The squelch voltage is applied to grid 1.

When squelched, grid 1 is negative and the tube is inoperative because of the bias developed across R1 and R2. To open the squelch, a positive voltage must be applied to grid 1. This can be obtained from the screen of an avc-controlled i.f. amplifier as shown.

When no signal is being received, the avc voltage is low and the i.f. amplifier tube draws maximum screen current. Hence the voltage across R3 and R4 is low. An incoming signal raises the avc voltage, and screen voltage rises. Grid 1 of the 6BN6 tube now becomes positive and the tube allows the audio signal to get through.

This circuit is for an AM receiver (CB set, etc.). The positive voltage can also be derived by rectifying the i.f. signal as shown in the "alternate" portion of Fig. 7.

For FM receivers, the positive voltage can be obtained by rectifying the signal as before or by employing a noise amplifier and rectifier as in Fig. 8. When noise is present, in the absence of a signal, the noise produces a negative voltage which biases grid 1 to cutoff. When the noise is quieted by a signal, the 6BN6 conducts.

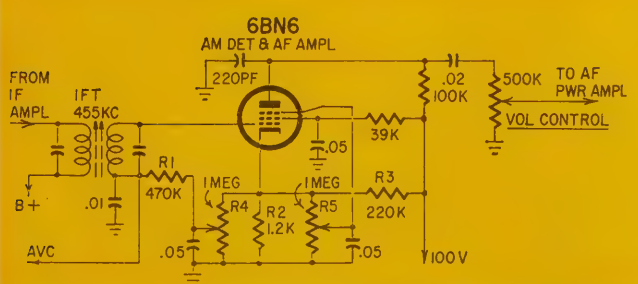


Fig. 5—Combined AM detector and audio amplifier.

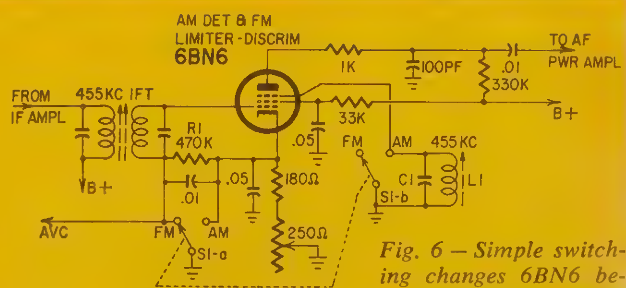


Fig. 6 — Simple switching changes 6BN6 between AM detector-amplifier and FM limiter/discriminator.

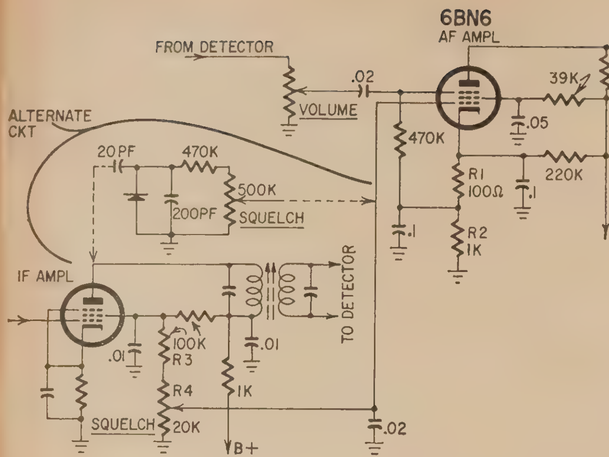


Fig. 7 — Squelch circuit applies cutoff bias to grid 1, audio signal to grid 3.

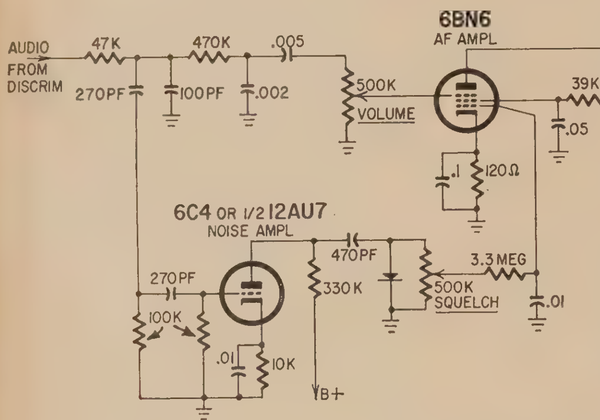


Fig. 8 — Squelch circuit for FM receivers uses amplified noise to keep 6BN6 (audio amplifier) cut off with no signal.

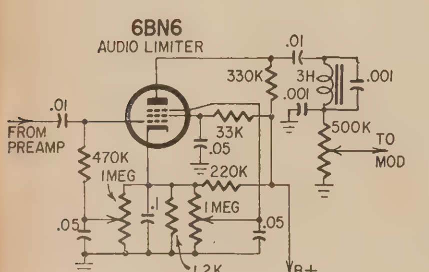


Fig. 9—Modulation clipper–limiter. Circuit is useful for ham and CB transmitters, and for PA work.

Modulation limiter or mixer

The 6BN6 may also be used as a modulation limiter. As shown in Fig. 9, the audio signal from a microphone preamplifier stage, or directly from a high-output carbon microphone, is fed into grid 1. Bias controls for both grids 1 and 3 have been included to allow for adjustment for optimum performance. A low-pass filter (optional) is shown at the output of the limiter. It restricts audio response to the voice band and filters out high frequencies generated by the clipping action.

The 6BN6 can also be used as an electron-coupled audio mixer. Two different audio signals are fed into grids 1 and 3 as shown in Fig. 10. Bias can be adjusted to permit linear operation when the signals are at low levels.

Control and timing circuits

An AND circuit using a 6BN6 tube is shown in Fig. 11. The tube is cathode-biased to cutoff. When a positive voltage is fed to grids 1 *and* 3 simultaneously, plate current flows and the relay is energized.

By grounding the cathode and applying a small positive voltage to both grids (Fig. 12), an OR circuit is formed. Plate current can be cut off by applying a negative voltage to either grid 1 *or* 3. This causes the relay to drop out.

The sharp cutoff characteristics of the 6BN6 make it a good tube for electronic timing circuits. In the circuit shown in Fig. 13, grid 1 is biased to cut off at about –4.5 volts by adjusting R1, which is across a 6-volt battery. Grid 3 is biased 3 volts positive by another battery. The relay is de-energized since plate current is zero.

When switch S is in the off position, capacitor C is charged to 9 volts by still another battery. When set to the on position, the 9-volt positive charge in C is applied to grid 1. This voltage is in series-opposition to the –4.5 volts bias, making the grid 4.5 volts positive.

When the charge drops to 3.68% of full charge, or 3.3 volts, the voltage on grid 1 will have dropped to –1.2, and the relay will fall out. If the timing resistors are set to insert 1 megohm in one bank and 0.1 megohm in the other, this will occur in 1.1 seconds.

Due to variations in relay characteristics, tube, aging, etc., error is minimized by making grid 1 bias adjustable.

The possible applications for the 6BN6 are myriad. The circuits here are offered to stimulate ideas and as a take-off point for the experimenter. END

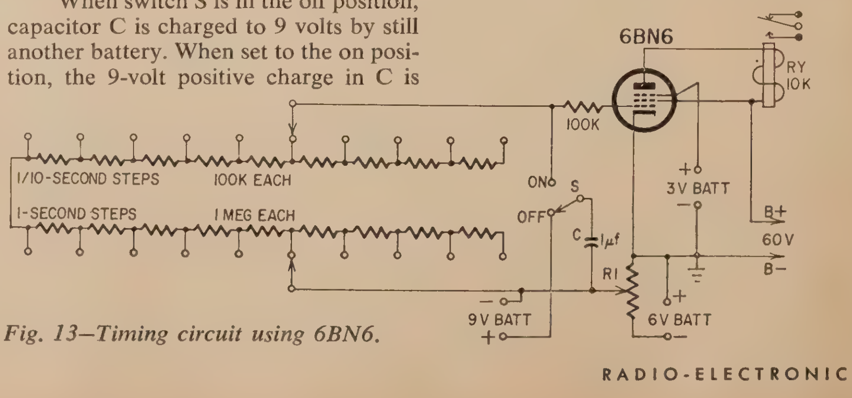


Fig. 13—Timing circuit using 6BN6.

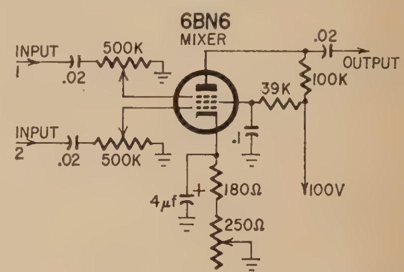


Fig. 10—Audio mixer applies different signals to grids 1 and 3. Can be straight amplifier or limiter.

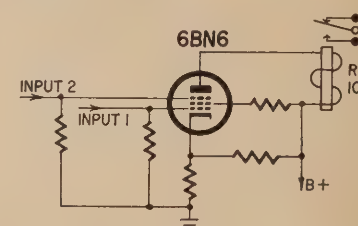


Fig. 11—A 6BN6 AND circuit. Tube conducts only when both grids are driven positive.

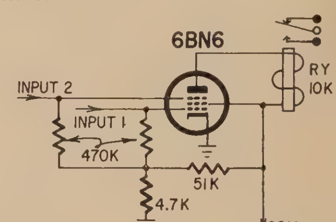


Fig. 12—In this OR circuit, both grids are normally positive, making tube conduct. When either grid is biased negative, tube is cut off.

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

MULTIVIBRATORS AND BLOCKING OSCILlators make nice waveforms, but not the kind we want for TV sweep. So we add little R-C networks to come out with the kind of wave we have to have. Trouble in these circuits is pretty simple if you know what to look for and where to look for it. Let's take a vertical oscillator–output circuit, f'rinstance (Fig. 1).

This ought to look familiar—it's used in lots of sets. We didn't put any tube numbers in—they are all the same as far as this is concerned. The parts values are taken from a Dumont 306, if you'd like to know, which used half a 12AT7 and a 6S4. Makes no difference anyhow.

We've circled the saw-forming networks. More than you thought there were, huh? Note that some parts are actually part of more than a single network! The .0022-μf capacitor, for instance. Now let's see what happens in an actual set if something goes sour in this circuit.

Troubles are no more complicated than a change in value of parts. Resistors get bigger or smaller, capacitors leak, and so on. A good starting place for tests is at the oscillator plate. We ought to see a peaked sawtooth, like Fig. 2-a. Be sure to use a low-capacitance probe for this. These circuits are all very-high-impedance, and even the smallest extra capacitance causes troubles. Even with a low-cap probe, you'll probably have to reset the hold control

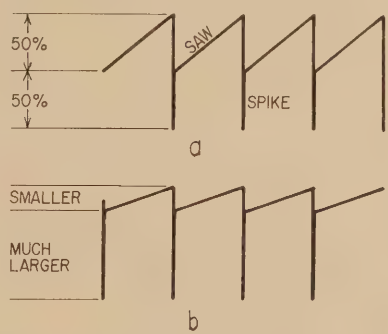
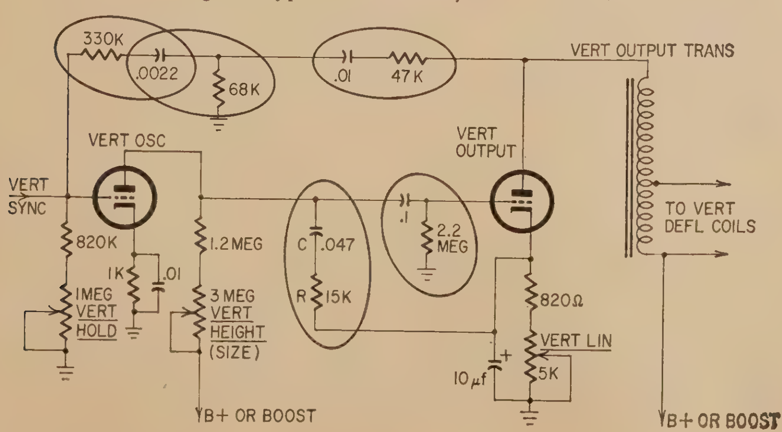


Fig. 2-a—Normal waveform on output tube grid or oscillator plate: equal spike and sawtooth amplitudes. Exact ratio may vary from set to set. b—If time constant of output grid circuit increases (either R or C gets larger), saw flattens and spikes get longer.

Fig. 1—Typical vertical deflection circuit.



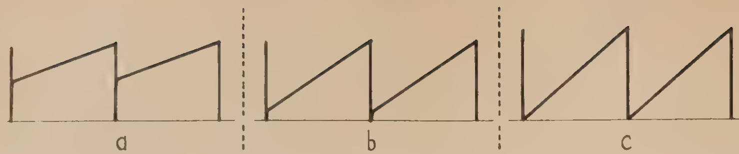


Fig. 3-a—Normal waveform for circuit of Fig. 1 (R = 15,000 ohms). b—Resistor R reduced to 5,600 ohms. c—Down to 2,000 ohms. No spike at all. Pure sawtooth!

when you clip the scope on, to stop the picture. This is normal, and you can set it back after you disconnect the test equipment.

In Fig. 2-a, notice that the saw and spike parts of the wave are about the same in amplitude. This is good, and seems to be about normal for many sets. Now, what happens if part values change? Let's take the grid network, R and C in Fig. 1. If either part goes up in value, the saw flattens out and the spikes get longer (Fig. 2-b). But, you say, the capacitor can't get bigger "naturally." Right. But suppose the set's been in a shop where they can't read color codes or schematics, or can't read, period? There could be a 0.47 in there instead of the .047! (Don't think this can't happen! I've taken a few of 'em out!) Same results in either case, and only two parts to check. Here, the resultant waveform will always look something like Fig. 2-b.

Now, if the resistor gets smaller in value, we start losing the spike part of the wave, and the sawtooth gets steeper, as in Fig. 3. The original resistor here is 15,000 ohms. Fig. 3 shows the resulting waveform as this resistor is reduced in value.

Notice that we keep losing more and more of the spikes as the resistor gets smaller, until finally we have nothing but a pure sawtooth. What effect does that have on the picture? You'll see bad distortion: loss of height, and vertical linearity, beyond the ability of the controls to correct. In quite a few cases, bad waveform affects sync or hold, and the picture rolls very quickly, if sync disappears for a moment.

The same trouble can happen in the feedback network (the string of resistors and capacitors connected between the output tube plate and the oscillator tube grid). The purpose of this is to feed back a pulse from the output to the input, to keep the oscillator running. The R-C networks here not only shape the pulse (from a "peaky" sawtooth to a spike), but regulate its *amplitude*. After all, we're coming from about 1,200-volt peak pulse down to about 50 or 60 volts, and we have to cut down somewhere. This network does it—see the shunt resistor to ground, the 68,000-ohm unit? (Fig. 1.) That's a part of it, and the impedance of the capacitors and resistors does the rest.

Troubles here usually affect the oscillator frequency first. They also ruin linearity, of course, but usually trouble seems to show up as poor hold before linearity gets too bad. For instance (a very common trouble), if that .0022-μf capacitor shorts out or gets leaky, the oscillator will slow down so far that you can get a stable picture only by settling for two complete pictures on the screen (30 cycles).

So use your scope, your eyes and your head when you find these mysterious troubles in "the vertical," and they won't be so hard after all! Be sure to check all new capacitors for leakage before you put 'em in.

Stereo earphones with 3-channel stereo

I hooked up a pair of stereo earphones to my own three-channel set. Got a horrible sound! The phones have a 3-wire "adapter". Checking the schematic of the amplifier, I see the C-terminals aren't ground, but the 4-ohm taps are!

How can I hook these up without disturbing the feedback loops in the amplifier?—A. H., Westbrook, Me.

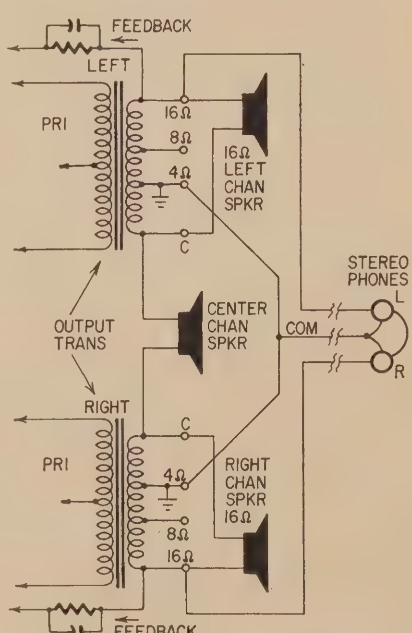


Fig. 4—Amplifiers with common 4-ohm taps need this kind of headphone connection.

Your original hookup is like Fig. 4: the center speaker is fed from a combination of L and R signals. Your "adapter" has a common ground lead. Tie it to the 4-ohm taps, which *are* ground, and then hook the phones to either the C or 16-ohm taps. Either tap will feed the phones from a 4-ohm source, but that shouldn't hurt anything. I don't think you'll have to disconnect the center speaker.

You might hook a 330-ohm resistor in series with each "hot" lead to the phones. Protects them from overload damage and improves signal-to-noise ratio.

Needs schematic

I'm just getting started in TV service, and I need some help. I'm trying to repair an old "Monarch" with poor horizontal sync, and I can't find a diagram for it. I am enclosing a tube and chassis layout. Can you help me find a schematic?—J. M. B., Lakewood, Calif.

I'm afraid I'm not going to be too helpful on that schematic; I can't locate anything at all under the name of "Monarch."

However, cheer up. All is not lost. This will happen to you many times in the future, as it does to all of us, so this is a good time to learn how to deal with such situations.

The experienced technician can almost always determine the type of oscillator circuit used from certain characteristics, such as the controls. In this case, your sketch shows "Hor Freq" and "Hor Waveform" controls on the back apron of the set. This means that the oscillator circuit must be the synchroguide type, as this is the only one using *these two* controls. If the horizontal hold control were a variable resistor on the front panel, and there were a ringing coil in the circuit, it would be a stabilized multivibrator, and so on.

In the April 1960 issue of this magazine, you'll find a very detailed article by R. D. Jacques (page 55) dealing with horizontal oscillators. It covers all the major types and their peculiarities. Use the methods outlined there, check the circuit out one piece at a time, and you'll find the trouble.

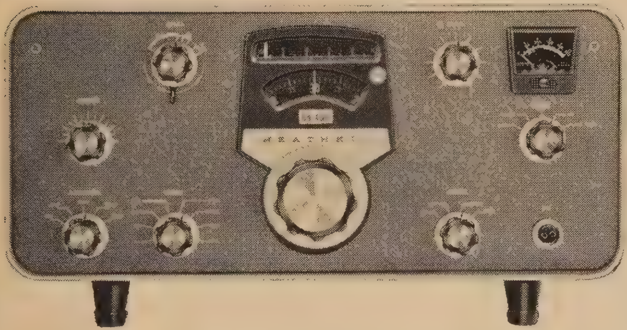
Tube to transistor conversion?

Enclosed is a diagram of a tube type hearing aid. I've been trying to change it to a transistor type, with no luck. I want to use the same parts and general diagram. How can I do this?—F. F., Elizabeth, N. J.

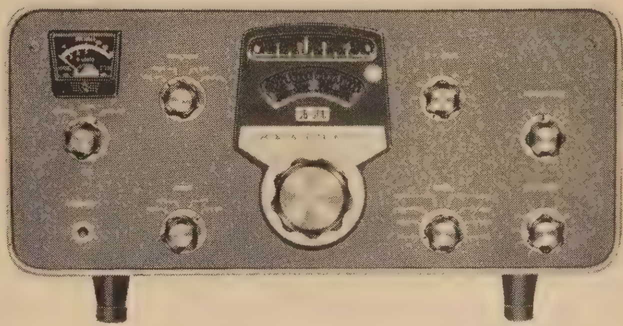
I hate to discourage you, but I don't think this is going to work. Tubes and transistors aren't that much alike. Parts aren't interchangeable; vacuum-tube circuits are high-impedance, transistors low-impedance. Transistor biasing is opposite to tube biasing. You'd have to replace nearly every part in the unit, so you might as well build a new one from scratch.

Several parts houses list small transistor audio amplifiers, ready-built, that could very easily do what you want. Look in the ads in the back of this magazine! END

NOW THERE ARE TWO...



SB-400 TRANSMITTER



SB-300 RECEIVER

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Heavy-gauge aluminum construction throughout provides extra-strength and light weight. Complete shielding by partitioned chassis construction minimizes TVI and eliminates instability. Order your SB-400 today! Enjoy a new high in operating versatility and convenience with all the deluxe design features that guarantee finest amateur radio communications.

Kit SB-400..30 lbs................$325.00

SPECIFICATIONS—Emission: SSB (upper or lower sideband) and CW. **Power Input:**170 watts CW, 180 watts P.E.P. SSB. **Power output:** 100 watts (80-15 meters), 80 watts (10 meters). **Output impedance:** 50 to 75 ohm —less than 2:1 SWR. **Frequency range:** (mc) 3.5-4.0; 7.0-7.5; 14.0-14.5; 21.0-21.5; 28.0-28.5; 28.5-29.0; 29.0-29.5; 29.5-30.0. **Frequency stability:** Less than 100 cps per hr. after 20 min. warmup. **Carrier suppression:** 50 db below peak output. **Unwanted sideband suppression:** 55 db @ 1 kc. **Intermodulation distortion:** 30 db below peak output (two-tone test). **Keying characteristics:** Break-in CW provided by operating VOX from a keyed tone (Grid block keying). **ALC characteristics:** 10 db nominal @ 0.2 ma final grid current. **Noise level:** 40 db down from single tone output. **Visual dial accuracy:** Within 200 cps (all bands). **Electrical dial accuracy:** Within 400 cps (all bands). **Audio input:** High impedance microphone or phone patch. **Audio frequency response:** 350 to 2450 CW at 6 db. **Power requirements:** 80 watts STBY, 260 watts key down @ 120 V AC line. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

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The first in the new Heathkit SSB series! A new dimension in quality features, smooth operation and performance, you never before thought possible in kit form!

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SBA-300-1 Optional AM Crystal Filter (3.75 kc)..1 lb........................$ 19.95

SBA-300-2 Optional CW Crystal Filter (400 cps)..1 lb........................$ 19.95

SPECIFICATIONS—Frequency range (megacycles): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. **Intermediate frequency:** 3.395 megacycles. **Frequency stability:** 100 cps after warmup. **Visual dial accuracy.** Within 200 cps on all bands. **Electrical dial accuracy:** Within 400 cps on all bands. **Backlash:** No more than 50 cps. **Sensitivity:** Less than 1 microvolt for 15 db signal plus noise-to-noise ratio for SSB operation. **Modes of operation:** Switch selected: LSB, USB, CW, AM. **Selectivity:** SSB: 2.1 kc at 6 db down, 5.0 kc at 60 db down (crystal filter supplied). AM: 3.75 kc at 6 db down, 10 kc at 60 db down (crystal filter available as accessory). CW: 400 cps at 6 db down, 2.5 kc at 60 db down (crystal filter available as accessory). **Spurious response:** Image and IF rejection better than 50 db. Internal spurious signals below equivalent antenna input of 1 microvolt. **Audio response:** SSB: 350 to 2450 cps nominal at 6 db. AM: 200 to 3500 cps nominal at 6 db. CW: 800 to 1200 cps nominal at 6 db. **Antenna input impedance:** 50 ohms nominal. **Muting:** Open external ground at Mute socke . **Crystal calibrator:** 100 kc crystal. **Front panel controls:** Main tuning dial; function switch; mode switch; AGC switch; band switcn; AF gain control; RF gain control; preselector; phone jack. **Rear apron connections:** Accessory power plug; HF antenna; VHF #1 antenna; VHF #2 antenna; mute; spare; anti-trip; 500 ohm; 8 ohm speaker; line cord socket; heterodyne oscillator output; LMO output; BFO output; VHF converter switch. **Tube complement:** (1) 6BZ6 RF amplifier; (1) 6AU6 Heterodyne mixer; (1) 6AB4 Heterodyne oscillator; (1) 6AU6 LM osc.; (1) 6AU6 LMO mixer; (2) 6BA6 IF amplifier; (1) 6AU6 Crystal calibrator; (1) 6HF8 1st audio, audio output; (1) 6AS11 Product Detector, BFO, BFO Amplifier. **Power supply:** Transformer operated with silicon diode rectifiers. **Power requirements:** 120 volts AC, 50/60 cps, 50 watts. **Dimensions:** 14⅞"W x 6⅝"H x 13⅜"D.

MORE TO COME!

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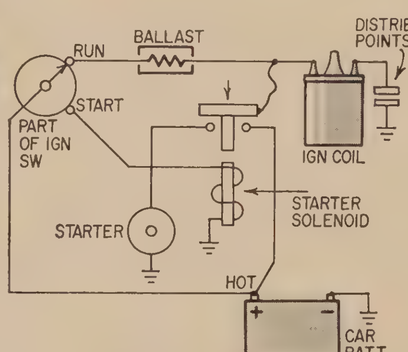
Troubles in Transistor Ignition System Hookup?

Some of our readers have written in about an apparent difficulty in the hookup of the transistor ignition system described by John R. Gyorki in the April issue (page 53). Not in the ignition system itself, but in the connections to the car's ignition switch. They complain that the circuit as shown in Fig. 3, page 54, will cause the starter solenoid to remain energized all the time, once the key is turned to RUN position.

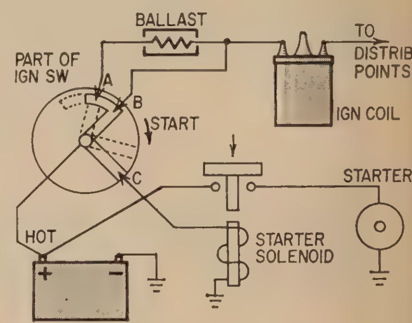
That isn't so. This confusion arises from not checking the car's wiring diagrams! The average ignition switch is more complex than the simplified spdt type in Figs. 3 and 4. These diagrams show only the switch contacts used to short out the *original* ballast resistor while starting. This is *not* the contact used to energize the starter solenoid! Check your car's wiring diagram and see.

We checked circuits used in popular cars: Ford, Chevrolet, Pontiac, Buick, etc. Fig. 1 shows how they do this. Notice that Ford and Chevrolet (Fig. 1-a) use a special contact on the starter solenoid itself for shorting the ballast. Pontiac and others (Fig. 1-b) use entirely *separate* contacts on the ignition switch for shorting the ballast and operating the solenoid.



a

Note that the Ford and Chevrolet "short-out" circuit doesn't go anywhere near the ignition switch at all; it's done entirely by the isolated moving contact of the starter solenoid. In Pontiac, etc., when the switch is turned to START, contacts A and B short out the ballast resistor; returning to RUN leaves contact B entirely open. The starter solenoid is closed in this system by contact C alone.



b

You can always tell on the late cars what system is used by just *looking* at the starter solenoid! There will always be the two big wires, one to battery, the other to the starter; however, if it has *two small wires*, and two small terminals, it's the Ford-Chev. jumper system.

If you build this system, check the wiring diagram of *your* car before installation, to see how this particular circuit is wired. I hooked the original unit up on my wife's car, a Ford, and ran it for about 10 days; it worked beautifully, and I had no trouble at all with it during that period.—*Jack Darr*

[Mr. Gyorki has, however, noticed an error in Fig. 4. His original drawing shows a lead running from the tap on the 1-ohm ballast resistor to the hot terminal on the starter motor. The tap should be connected to the shorting bar on the starting solenoid instead of to the starter. This system has been used on a 1963 Mercury for almost a year.—*Editor*]

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

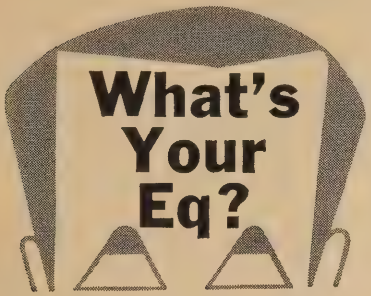
Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics and the Electrical Experimenter on file.

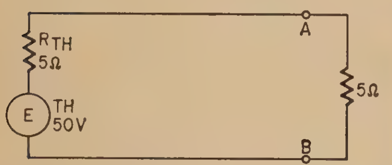
IN JUNE, 1914, ELECTRICAL EXPERIMENTER

The "Electro" Detectiphone and Radio Amplifier, by H. Winfield Secor.
A Simple "Quenched" Spark Gap for Small Power Wireless Sets.
Wireless Receivers, by H. J. Lucas.
Lindsay's Early Wireless.
Long-Distance Speech.
Talk Across Ocean Soon, Predicted by Marconi.

Answers to



This month's puzzles are on page 33



Maximum Power

The first operation is to reduce the circuit to its equivalent Thevenin generator. To do this, we first find the Thevenin voltage at point A.

$$E_A = E \times \frac{10}{10+10} = 50 \text{ volts} = E_{TH}$$

Next, looking back into the circuit from points A and B, with E reduced to zero, we see R_o and R_{int} in parallel.

$$\frac{10 \times 10}{10+10} = 5 \text{ ohms} = R_{TH}$$

Since the "internal resistance" is now 5 ohms, the new load must be 5 ohms for maximum power transfer. Using any of the power formulas, (I^2R, for instance) the power in the new load is now found to be:

$$P = \left(\frac{50}{10}\right)^2 \times 5 = 125 \text{ watts}$$

No Volts

Silicon diodes have a very high back resistance, much higher than the 300,000-ohm resistance of the meter. The diode of a series pair that is not shunted by the meter has to withstand virtually all of the drop, since its back resistance is so much higher than that of the meter. The shunted diode then has a negligible drop across it. While the piv rating of the unshunted diode is temporarily exceeded during the test, it is undamaged due to its conservative rating.

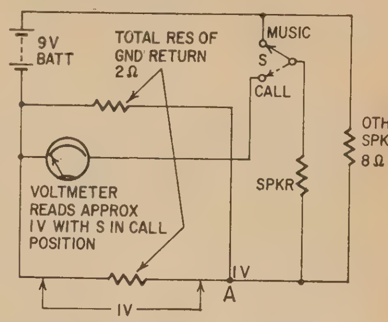
Music—Intercom Trouble

Background music will overload the intercom amplifier when S is in CALL position. This occurs because of a built-in ground loop and the all-too-prevalent idea that a common or ground lead is "cold" just because it happens to be in the return circuit.

To make it easier to see how this ground loop occurs, we have taken the circuit and substituted a battery for the background music amplifier and a voltmeter for the intercom amplifier. Resistors are substituted for the speaker loads. With the arbitrary values shown, we can see that at point A there is a 1-volt drop across the parallel resistances of the ground wires. With the switch in the CALL position, this voltage drop will be indicated on the meter.

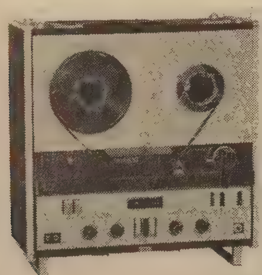
In the music–intercom system this voltage is fed directly into the intercom amplifier and amplified several hundred times.

The obvious and simple solution is to use a dpdt switch for S so that both sides of the speaker will be disconnected when a call is made. END



SONY TAPE RECORDER TC-600

THIS RECORDER HAS SOME VERY GOOD specifications and, although its price is above the "cheap" range, one does not readily believe such excellent specs for a four-track machine until they prove out. This machine fulfilled its promise. With it, you can tape your stereo discs and play them back without being able to detect any difference, which is saying something.



SPECIFICATIONS
(All specifications are the manufacturer's)

Type of recorder: 4-track stereo or mono, vertical or horizontal operation
Frequency response: 30 to 18,000 cycles, ±1 db at 7½ ips
Signal-to-noise ratio: 50 db
Flutter and wow: 0.1% or less at 7½ ips
Bias frequency: 100 kc
Speeds: 7½ and 3¾ ips
Power requirements: 80 watts, 110-117 volts 60 cycles (50 cycles optional)
Inputs: two high-level line; two mike or equalized magnetic phono (switch-selected)
Outputs: to 600-ohm 8-db line; 600 ohm binaural headphone monitor
Drive: single hysteresis-synchronous motor
Price: $299.50

It handles well, provided you move the main transport control lever decisively. If you move it too deliberately, it passes through a spot where the tape gets free and flows everywhere—a well known phenomenon with recorders! But move the lever with a confident "snap" and it controls the tape extremely well. The automatic stop is unobtrusive at feeding time and works effectively.

The physical design of this unit is good, for either permanent installation or the most complete portability. The TC-600 stands up on fixed "handles" for vertical operation (there is an additional spring-loaded handle for more convenient carrying), or it can be operated in the horizontal position equally well. Connections for everything except mikes are located under a hinged lid with clip fasteners, at the top in vertical operation or back when horizontal. The removable cover has neat, secure clips to carry the twin mikes and their leads in a zippered plastic case providing maximum accessibility for all other leads.

The footage indicator *is* a footage indicator, not merely a place spotter, and it keeps count with all normal tape movements. Independent control of left and right channels, so one can be operated in record while the other is in playback, enables the unit to be used for an endless variety of "special" effects.

Playback and record functions are completely separate, so that a recorded program can be monitored immediately. As well as avoiding disappointment in more serious uses, this feature makes possible the fascinating "confusion" game—allowing a person speaking into the mike to hear his own playback, so he cannot speak without stammering! The simple monitor/line-output controls provide maximum flexibility in use.

Microphone and auxiliary inputs can be mixed for combination and re-record effects. First-stage amplification uses transistors, while the main amplification uses tubes—a good marriage in this particular design. Of course, like all "professional" recorders, this one provides line output at normal line level; it does not feed loudspeakers directly. It can be used with any suitable amplifier.

The mikes are very good, compared with most of the "inexpensive" types used with home recorders. Extremely good realism is possible for home recordings. I had my family "act natural" in front of the two-mike combination, and the playback was unbelievably real.

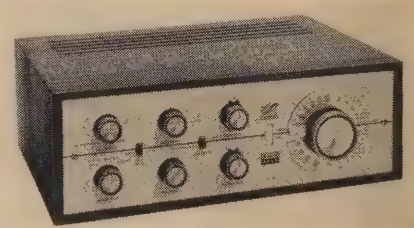
The owner's manual explains all the functions very well, and gives step-by-step procedure for loading tape, recording and playback in normal four-track stereo mode, mixing programs, providing "sound on sound" and using tape for teaching (by using one channel as "master" track and the other so the student can compare the sounds he makes with those he is attempting to copy). There are maintenance and lubrication data and a glossary of tape talk is included.

The Sony 600 will naturally take a little playing around to find out how to do various "extra" things you may want. But when you get to know it, you'll find it a very versatile instrument. It's a recorder with which familiarity brings confidence.—*Norman H. Crowhurst*

EICO 2536
FM STEREO RECEIVER

THE EICO 2536 IS A NEAT PACKAGE—ONE of the smaller complete FM stereo receivers. Its sound is pleasing and its FM sensitivity adequate.

I like its looks: brushed aluminum panel, nice and thick, with neat brown markings screened on, and a blue-green light from the tuning eye and from a sector behind the clear plastic tuning dial. And I liked the simplicity of the controls and panel markings. (Which reminds me: Eico calls its channels 1 and 2 rather than A and B or L and R or Left and Right.)



SPECIFICATIONS
(All specifications are the manufacturer's)

FM & Multiplex sections
IHF usable sensitivity: 3µv (30 db quieting)
Sensitivity for phase-locking (in stereo): 3 µv
Sensitivity for full limiting: 10 µv
IHF capture ratio: 3 db
IHF signal-to-noise ratio: 55 db
I.f. bandwidth: 280 kc at 6-db points
Ratio detector bandwidth: 1-mc peak-to-peak separation
IHF harmonic distortion: 0.6%
Stereo harmonic distortion: less than 1.5%
Stereo channel separation: 30 db at 1 kc

Amplifier section
IHF music power: 36 watts (both channels)
Continuous power: 28 watts (both channels)
IM distortion: 2% at 14 watts, 0.7% at 5 watts, 0.2% at 1 watt
Harmonic distortion: 0.6% at 10 watts, 40 cycles to 10 kc; 0.2% at 1 watt, 30 cycles to 20 kc
IHF (continuous) **power bandwidth:** 1% harmonic distortion, 30 cycles to 20kc.
Frequency response: ±1 db, 15 cycles to 40 kc
Sensitivity: phono, 2.3 mv; others 250 mv
Noise: 65 db below average phono cartridge level (10–15 mv)
Power requirements: 120 volts, 60 cycles, 165 watts, no signal
Price: Kit, $154.95; wired, $209.95

The tuner in the 2536 performs very respectably. This might be expected—there are four 6AU6 i.f.–limiter stages. The front end is a dual triode (6AQ8), of which the first section is a grounded-grid rf amplifier, the second a reflex (self-oscillating) converter. A 6AL5 is the ratio detector.

The multiplex circuit is of the matrixing type. Separation seemed to equal that of any recent tuner.

The i.f. and detector circuits are on one long etched circuit board, prewired and dropped into place, held to the main chassis by screws. The multiplex circuit is a similar board. The rest of the chassis is point-to-point hand-

wired, but it uses prepackaged ceramic circuits extensively, for tone control and filter networks, etc.

All wiring is neat and open and easily accessible for servicing.

But the 2536 does have several characteristics that made it—to me—fall somewhat short of perfection. Perhaps you'd learn to love them, or perhaps they'll drive you crazy in a few weeks. In any case, they ought to be mentioned.

One of these things is loud switching pops between source selector positions. This comes from interrupting dc: the tuner i.f.'s are disabled in the PHONO, TAPE and AUX position. But there is another pop between FM and FM STEREO. Why? (And these are *loud*—enough to make my speakers say "oof" and for me to feel the pops in my chest!)

Number two: the stereo indicator. To find out whether you're receiving stereo (other than by listening, of course), you must first have the selector in FM STEREO and then, as you tune each station, depress a spring-return slide switch. If the station is broadcasting stereo, the electron-ray tube (window next to the tuning dial in the photo; it's also used as a tuning indicator) loses its shadow. Not bad, except that depressing the switch makes another violent *pop!* in the speakers and momentarily kills the sound. And the edge of the slide switch bites into the fingertip. Silly to mention it, maybe, but it seems to me to be one of the things somebody should have noticed and corrected before the unit was marketed.

Third, tuning with the electron-ray tube. I often found it easier to tune by ear, which is a heresy today. On strong stations, the two-hump i.f. curve is apparent in the action of the ray tube. As you approach the center of the channel, the bright parts converge and then diverge; then converge again and finally diverge as you tune away from the station completely. The object of the game is to tune for a minimum between two maximums. On some weaker stations, the sound drops off clean on one side of center, but gets gritty with slight mistuning to the other side.

I missed a headphone jack. (I've come to like listening with phones, and, from all indications, other people have, too.) But the 2536 has a tape monitor switch, with appropriate jacks at the back, to permit you to monitor a tape recording off the tape as it's being made, if your recorder has separate playback heads. Also, there's a BLEND control: fully clockwise, the two channels are "jumped" together and the sound is monophonic; fully counterclockwise, a switch clicks and the control is out of the circuit altogether, for maximum stereo separation.—*Peter E. Sutheim*

test equipment reports

GC Electronics Automatic Tube Tester
Model 36-802

ONLY THE MOST INEPT DO-IT-YOURselfer will have trouble testing his (or her) TV and hi-fi tubes on this automatic tube tester.

Originally developed as a floor model DIY checker (model 36-800) with space for a stock of tubes in a showcase below the checker, it has been put out as a counter model for the busy technician or dealer who finds it more profitable to let the customer do his own checking. To test a tube with the 36-802, all a customer has to do is follow the simple directions:

1. Find the correct socket opposite your tube type number on the convenient roll chart.

2. Insert your tube into the appropriate socket.

3. Depress the START button fully and release.

Then automation takes over—making tests for shorts, leakage and quality. No knobs to twist loose or switches to break from rough handling.

Excessive leakage or a short within a tube lights the corresponding indicator lamp on the tester. Once the light has been triggered, it stays on. The tester stops automatically. It will not cycle to test the tube for quality. This protects the meter from possible damage. A flashing sign at the right of the meter indicates that the tube is defective.

If a tube passes the first part of the test cycle, the meter then indicates the quality of the tube on a BAD–?–GOOD scale.

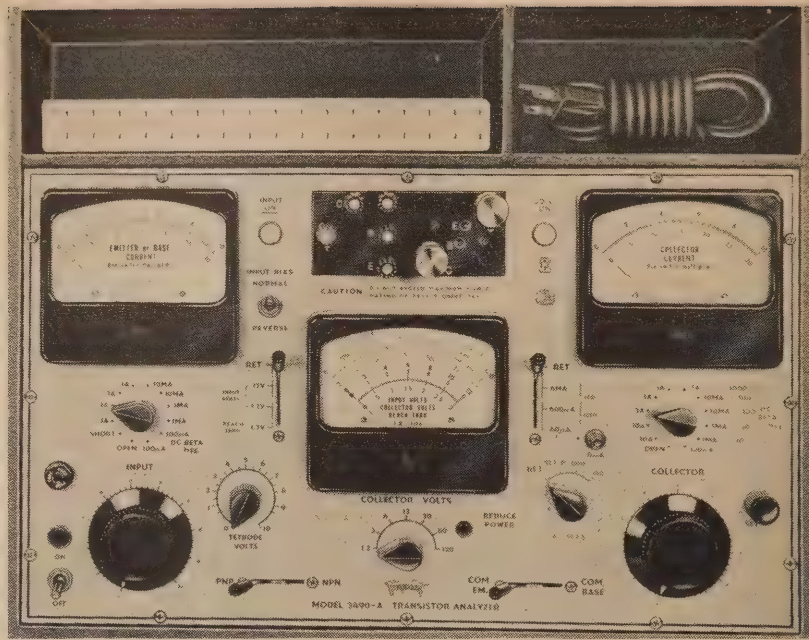
Fuses and pilot lamps are tested by placing them across a test block mounted in the lower left corner of the meter panel. If the fuse or pilot lamp is good, the indicator lamp glows. The test cycle initiated by the START button is not used.

Vibrators from auto radios and CB mobile equipment can also be tested. They are plugged into the proper socket just to the left of the meter, and the START button pressed. When the vibrator is in good condition, both lamps of the vibrator test indicator glow equally. A slight difference in brilliance does not indicate a defect—just that the vibrator contacts are slightly worn. Usually the vibrator does not need to be replaced just yet.

To keep the automatic test circuits accurate, a calibration box can be plugged into the electronic circuity. It sets the SHORT- and LEAKAGE-indicator sensitivity controls, the QUALITY meter and the cycle timing.

The first part of the cycle (the tests for shorts and leakage) is adjusted for about 28 to 30 seconds duration. The quality test lasts about 8 to 10 seconds.

The instruction manual includes step-by-step calibration instructions and a troubleshooting chart for the instrument. The tester sells, at this writing, for $325. A floor model with storage space for tubes sells for $445. END



Triplett Transistor Analyzer Model 3490-A

THE TRIPLETT 3490-A IS NOT A TRANsistor *tester*—it is an *analyzer*. It is for those seriously involved in semiconductor electronics—who must have an exact knowledge of a semiconductor's characteristics.

The 3490-A analyzer does not use alphabetized switches or special sockets to make limited tests. Charts are not needed—all tests are set up from actual characteristics and ratings. It can make more tests on a transistor than a tube tester can on a tube.

For example, you can test transistors in either a common-base or a common-emitter connection. Eight tests can be performed on both n-p-n and p-n-p transistors.

Collector voltages to 120 are available. Collector current goes as high as 30 amperes. Base or emitter input currents up to 3 amperes are possible.

Three separate meters make it possible to monitor the applied collector voltage as well as the input and output currents constantly during all tests.

A 2¼ x 4½-inch piece of copper ¼ inch thick is used as a heat sink for power transistor and diode tests.

Direct readings of ac beta (H_{fe}) and dc beta (h_{FE}) are indicated directly on the meters. No mathematical calculations—just move decimal places according to the meter range being used (just as you do with a vom or vtvm).

The flexibility of this analyzer makes it possible to vary the input current, collector voltage and collector current to plot curves for individual transistors when the averaged curves published by the manufacturer are not exact enough. In this way the dc conditions for maximum ac beta can be found.

Reach-through or punch-through can also be found. The voltage on the open-circuited emitter is metered while the collector-to-base voltage is increased. The emitter voltage will remain within 500 mv or less of the base voltage until the reach-through potential is reached.

Diodes, too

The full-load forward-voltage drop of diodes, including rectifiers, is measured while average rated current flows through them. Peak inverse voltage (piv) can be applied to diodes under test. Reverse current flow through the diode is measured while the piv is applied. If a high current flows, the diode has changed its characteristics. (The diode may be usable if a "new" piv can be determined. Just increase the reverse voltage slowly until the current meter shows a slight deflection. The "new" piv is just below this point. The diode can still be used if the "new" piv is not exceeded.)

Along with clip leads and clamps (for holding power transistors to the heat sink), there is a 250-page *Transistor Reference Book* (M. W. Lads Publishing Co.). It lists the characteristics of more than 3,000 transistors. A cross-reference index using the Datadex system of identification by parameters simplifies substitution from available types of domestic and foreign transistors made by 64 manufacturers. List price of the 3490-A at this writing is $399.50. END

Coming Next Month in Radio-Electronics

SWEEP ALIGNING TV I.F.'S

Jack Darr tells you when to, and when not to, align. He describes the process graphically and in complete detail, and—to forewarn you of any unexpected results—shows some horrible examples and tells why they occur. Best and most thorough story on sweep alignment to appear for some time.

BUILD A SELECTIVE PHOTOELECTRIC CIRCUIT

You have seen ordinary photocell units—how they can indicate when an object passes, or even count objects. This circuit is selective—you can make it count objects passing in one direction, but not in the other. It can count a mixed group of nickels, dimes and quarters and come up with the *value* of the quantity counted, instead of the number of coins. Has unlimited uses.

DIG THOSE PRIVATE BRANDS?

Who makes the *Bradford?* Or the *Ambassador?* Have you ever puzzled over private brand television receivers or radios? Next month—a complete rundown of the manufacturers of private label equipment for department stores, automobiles and others.

RESISTOR DECADE BOX FOR POWER

Have you ever watched your decade box smoke as you use it? Or have you wanted to make measurements that you knew your substitution box couldn't handle? This box measures from 1 to 1,000 ohms in 1-ohm steps and dissipates 10 watts on the lowest ranges. Typical measurements are made with from 20 to 90 watts dissipation. Ideal for the experimenter, hi-fi service shop or industrial electronics technician.

You'll find these and many other articles, features and regular departments in next month's RADIO-ELECTRONICS.

JULY ISSUE (on sale June 18)

are you ready

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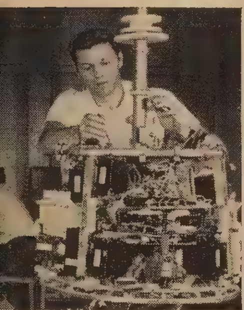

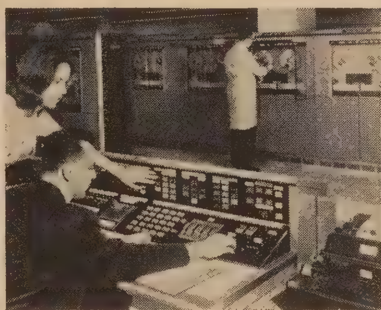
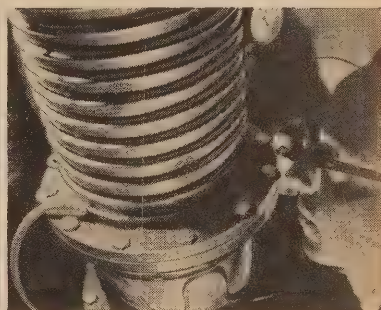

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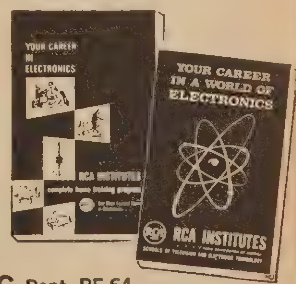


RCA INSTITUTES, INC. Dept. RE-64
A Service of the Radio Corporation of America,
350 West 4th St., New York, N. Y. 10014

RCA **The Most Trusted Name In Electronics**

1964 SEMI-ANNUAL INDEX

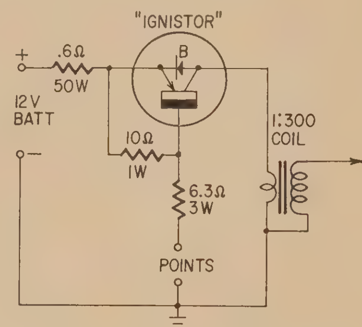
RADIO ELECTRONICS January-June, 1964 of Vol. XXXV

KEY TO SYMBOLS AND ABBREVIATIONS
* Construction Articles
† Section of full-length article
§ Transistorized
CI .... Service Clinic
Corr .... Correction
Corres .... Correspondence
NB .... News Briefs
NC .... Noteworthy Circuits
Pat .... New Patents
Tech .... Technotes
TTO .... Try This One
WN .... What's New
Regular departments not itemized are New Books, New Literature, New Products, Technicians' News, What's Your EQ?

New Semiconductors and Tubes

The Ignistor

A new component for electronic ignition systems, the *Ignistor*, is now being produced by Bendix.



An Ignistor is a transistor with a matched Zener diode connected between its emitter and collector, and housed in the same package. This of course takes less space, less time to install; is cheaper to make and cheaper to use than separate semiconductor components.

The new device comes in TO-3 and TO-41 (similar to TO-3 for shape and orientation of connections) packages with a variety of voltage and current ratings to suit particular applications. The diagram shows the simplest of several possible transistor ignition circuits suggested by Bendix for the Ignistors. The devices must be heat-sinked with a thermal resistance of about 2°C/watt.

Rectangular color CRT here

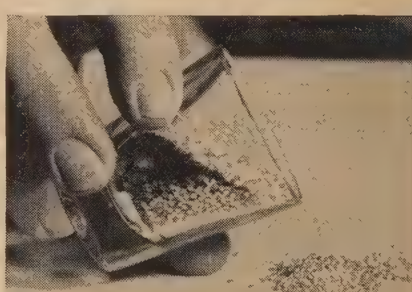
The long-awaited 23-inch rectangular color-TV picture tube is here. Motorola announced the new tube in a full-page ad in the Sunday, April 12 *New York Times*.

The new design became a production reality in late summer 1963. (See *News Briefs*, RADIO-ELECTRONICS, Aug. 1963, p. 16; Sept. 1963, p. 8.)

Compared to the standard 21-inch round tube, the new one has 274 square inches of viewing area, according to Motorola, instead of 261. The tube is 5.2 inches shorter than the conventional design. It is made by National Video Corp.

Tiniest diodes?

A diffused-junction diode with a double-glass hermetic seal may turn out to be the last stand of conventional discrete diodes. It's difficult to imagine complete diode assemblies any smaller (see photo)—these are about .060 inch in diameter and .030 inch high.



The design is available from Hughes Aircraft Semiconductor Div. in 10 varieties covering ratings up to 100 volts and 300 ma with 2-nsec switching speeds. The diode consists of a glass ring, which contains the silicon die already sealed in a layer of glass, and two metal end caps. It can replace several dozen existing diode types.

Sylvania plans 90° color CRT

Samples of a new 25-inch, 90° rectangular color TV picture tube are expected to be available late in 1964, according to Merle W. Kremer, general manager of the Electron Tube Div. of Sylvania.

Tentative specifications are being made available to set manufacturers so they can get started on cabinet designs.

For the time being, Sylvania intends to continue producing its 21-inch 70° round tube. END

booklets

New Literature

charts

catalogs

GYRO COMPONENTS. 41 data sheets on motors, resolvers, potentiometers, etc., give electrical characteristics, dimensions, test data and operating characteristics. 25 of the data sheets cover gyro components—induction, hysteresis types, pancake synchros, spin motors, etc. 16 other bulletins cover manufacturer's other recent products.—**Vernitron Corp.,** 52 Gazza Blvd., Farmingdale, N.Y.

TIN OXIDE RESISTORS described in 31-page illustrated test report, written after more than 53,200,000 part-hours. Includes 19 graphs.—**Corning Electronic Components,** Corning Glass Works, Bradford, Pa.

WALLET-SIZE CARD presents recommended values of selected physical constants. Available in lots of 100, at $2.50, from the Superintendent of Documents, Government Printing Office, Washington, D.C. Single copy requests free.—**National Bureau of Standards,** Office of Technical Information, Washington 25, D.C.

MINIATURE, SUBMINIATURE RF CHOKE KITS, 0.1 μh to 10 mh, explained in catalog sheet. Full performance data, diagrams.—**Nytronics Inc.,** 550 Springfield Ave., Berkeley Heights, N. J.

RADIO TROUBLE-SHOOTING GUIDE lists possible causes for various defects, such as completely dead radio, excessive hum, howling and squealing, fading, etc. Also lists commonly used tubes.—**Progressive Edu-Kits Inc.,** Hewlett, N. Y.

TAPE RECORDER HEAD designed for microminiaturization explained in *Catalog Sheet 3K17*. Dimension diagram, electrical characteristics, performance curves.—**Michigan Magnetics Inc.,** Vermontville, Mich.

BEAD THERMISTORS with high temperature stability described in spec sheet. Description, applications, resistance ratio vs temperature characteristics chart, diags, full specs.—**General Electric,** Edmore, Mich. 48829.

STOCK AND PRICE LIST for differential amplifiers, silicon transistors and planar transistors. 20-page list contains information on Zener diodes, silicon switches, micro gate controlled switches and other semiconductor devices.—**Semiconductor Specialists Inc.,** 5700 W. North Ave., Chicago 39, Ill.

PIEZOTRONIC PULSE, issue No. 1, 4-page buletin describes piezoelectric ceramic ladder and comb filters for communications and telemetry; Transfilter resonators that replace emitter bypass capacitors in i.f. amplifier circuits to double selectivity. Also details on measuring piezo ceramics, and on new triaxial accelerometer.—**Piezotronic Pulse Dept.,** Hal Choisser, 5700 W. North Ave., Chicago 39, Ill.

CAPACITORS detailed in 24-page booklet. Mylar and foil capacitors, metallized mylar, Teflon and foil types described. Charts and tables list all values and ratings in each type. Dimensions; temperature-characteristic plots. Manufacturer's numbering systems described with example.—**Texas Capacitor Co.,** 4310 Langley Rd., Houston 16, Tex.

DIGITAL CIRCUIT MODULES presented in 80-page *Catalog T-113*. Amplifiers, arithmetic circuits, drivers, flip-flops, inverters, logic circuits, multivibrators, level converters; power supplies, timing sources, system breadboards and related hardware. More than 175 circuits.—**Engineered Electronics Co.,** Marketing Services Group, Box 58, Santa Ana, Calif.

CATALOG for 1964, 2 colors, 32 pages, with photo and detailed specs. Complete line of stereo and mono hi-fi equipment, test instruments, ham gear, CB radios, transistor radios in kit and wired forms.—**Eico Electronic Instrument Co. Inc.,** 131-01 39 Ave., Flushing, N.Y. 11352 END

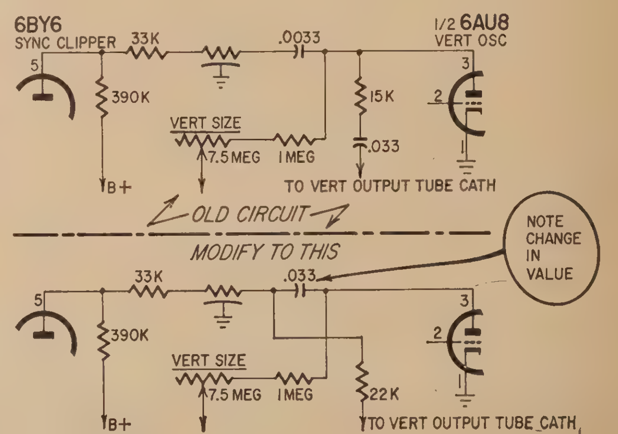
TV AND FM—reasons for bad reception and advantages of using rotor system outlined in 20-page booklet, available in quantity to all service technicians free of charge.—**Cornell-Dubilier Electronics Div., Federal Pacific Electric Co.,** 50 Paris St., Newark 1, N.J.

TECHNOTES

Zenith 16T20, 17T20

Complaint: Weak vertical hold, characteristic of this chassis.

Solution: Modify the vertical oscillator as shown in the schematics.—*Jim Wilhelm*



Series 1800 Emerson TV's: Assorted Troubles

These sets, like any others, have certain distinctive troubles. Most prominent are these:

1. Vertical roll after set warms up. Traced to high-resistance leakage between plate and grid of vertical oscillator V7-b. Cleaning the printed circuit board clears up the trouble.

2. Shorted (or otherwise bad) 6CU5 audio output can cause baffling agc and sync symptoms.

3. Faulty agc action and poor vertical sync, caused by bad C14 filter capacitor (0.47 μf from the i.f. agc line to ground).

4. No sound or picture: open video peaking coil L7-a and -b in output of video detector V6-b.—*A. Rusland*

Sneeze Changes TV Channels

I'm an inspector in a TV manufacturing plant that produces ultrasonically actuated remote control-equipped TV sets. One day while inspecting, I sneezed. The channel changed! I sneezed again. The channel changed again!

Ultrasonic noise components in sneezes and from air-powered screwdrivers and staplers sometimes trigger remote-control circuits to change a channel, mute the sound or even change the volume setting.—*James J. Porten*

Lost Color in Motorola TS-912

Intermittent loss of color in Motorola TS-912 chassis can be the fault of a misadjusted color killer control.

To adjust the killer control properly, the set should be thoroughly warmed up. Chroma and fine-tuning should be set to approximately their normal color-viewing position. Adjust the killer until color snow shows up in a black-and-white picture. Then back off until the color just disappears.—*Havens Electric Co., via TSA (Albany, N. Y.) Newsletter*

Watch Audio Gain in FM 2-Way Sensitivity Tests

Some technicians have trouble getting an acceptable sensitivity figure with FM two-way radios by aiming for 20-db noise reduction at the speaker terminals. If you use that approach, make sure you are not driving the last audio amplifier into limiting.

While it does not affect the *actual* sensitivity of the set, it will give you a completely wrong sensitivity *figure*. If you have to maintain the unit to a specification, say 1.5 or 2 μv, it will keep you looking in the wrong direction for quite a while.

To check for limiting in your set, watch the output meter while slowly turning the volume control from zero to full output. If the voltage follows smoothly all the way to the top, start looking somewhere else. If it seems to level off before you reach the end on the volume control, the audio amplifier is limiting. For this check, open the squelch control and use the noise voltage without any rf input.

To get an accurate figure, simply back off the volume control below the point where the output started to level off and check the sensitivity again. You will be surprised just how much difference this makes on some sets.

Since you are interested only in a 20-db reduction, irrespective of the actual level, and since it takes quite a few microvolts of rf input just to bring the level below limiting in your audio stage before any change can be noticed on the output meter, it is a good practice never to check sensitivity at full volume. This will improve not only your sensitivity figure but also its accuracy.—*A. Wiegert*

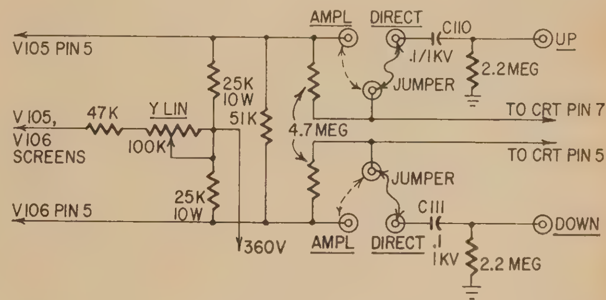
Hotpoint 21S501 "U" Line

This set had occasional horizontal bending or tear at top of raster. All voltages checked OK. The trouble was a leaky C74, .005 μf. Since this was one of those vertical chassis with the printed-circuit board covered by a grill, I also changed C75, 470 pf, to reduce the chance of further trouble. I used the tin snips to cut the grill.—*Joseph K. Nicholson*

[The printed-circuit board is protected by a perforated metal grill, a nonremovable part of the chassis. Holes in the grill make it possible to reach many of the parts; but without special tools, it is sometimes necessary to cut away part of the grill to reach certain parts.—*Editor*]

DuMont 304-A Scope

Used with jumpers on its "direct" (to CRT plates) input, there was no vertical deflection. I traced the trouble to an open

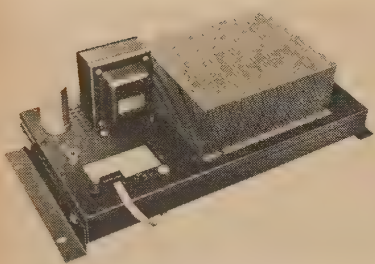


blocking capacitor (C110 in the diagram). An open C111 could have the same effect. Replacing the bad part fixed the scope.—*Clyde Rehberg*

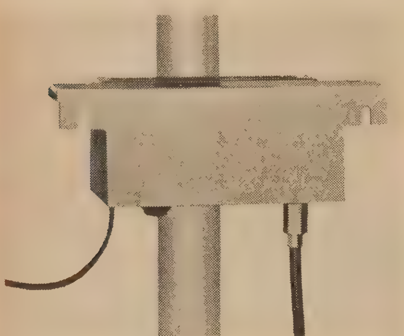
Quick Horizontal Efficiency Coil Adjustment

To adjust horizontal efficiency coils easily, connect a 400- to 450-ma pilot lamp in series with the plate of the horizontal output tube. Adjust the coil for minimum lamp brightness.—*TSA (Albany, N. Y.) Newsletter* END

new Products



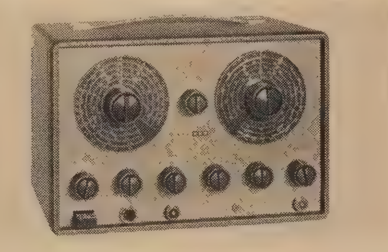
BROAD-BAND VHF AMPLIFIER. *Powerhouse,* upgraded version of MLA Masterline series. Delivers very high output to large TV–FM distribution systems. Useful on older MATV systems where cable losses high and pictures substandard. Driven by broad-band or single-channel amplifier.—**Blonder-Tongue Labs Inc.,** 9 Alling St., Newark 2, N.J.



SINGLE-CHANNEL PREAMPLIFIER, *Cablemaster, Model CMA for TV. Model CMA-FM* for FM. Low-noise preamp, flat bandpass provides excellent color reception. Weatherproof aluminum housing mast-mounted anywhere. Remotely powered with 18 to 20 volts dc, minimum gain 22 db on channels 2–13. *CMA-FM,* minimum gain of 18 db.—**Blonder-Tongue Labs Inc.,** 9 Alling St., Newark 2, N.J.

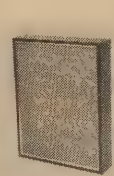
MULTIPLEX SIGNAL GENERATOR, *model MX-4* modulates shop's FM signal generator. Pilot oscillator frequency 19,000 kc; stability ±3.0 cycles; pilot subcarrier amplitude (variable to) 12% modulation. Multiplex subcarrier frequency 38 kc, stability ±66.0 cycles. Composite output signal L + R, 38 kc with L – R, 19 kc; amplitude (variable to) 5.0 v p–p. Output impedance 600 ohms. Audio oscillator frequencies 100, 300 cycles; 1, 3, 10, 67 kc; amplitude 1.0 v p–p; output impedance 600 ohms. Audio modulation modes: external L, R, L + R, L – R. 2½ x 7 x 3 in., 30 oz.—**C-W Engineering,** 1838 Mount Diablo Blvd., Walnut Creek, Calif.

TV/FM SWEEP-MARKER GENERATOR, *model 369,* post-injection marker; feeds only required sweep signal to input of circuit being aligned. At output, demodulator cable picks off signal, feeds demodulated signal to mixer stage where markers are added—combined signal then fed to scope. Sweep generator independent of marker generator. 5 ranges: 3.5–9, 7.5–19, 16–40, 32–85 and 75–216 mc. Tuning by 6:1 vernier dial and 330° scale. Output impedance 50 ohms. Re-



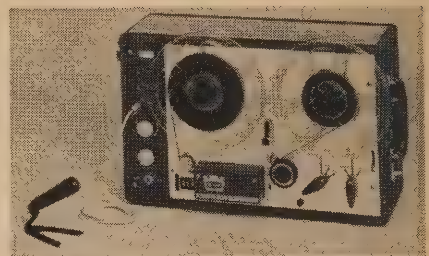
trace blanking. 3-stage agc circuit keeps signal level constant. Variable marker generator covers 2–225 mc. 4.5-mc marker crystal supplied. 6 tubes, 105–125 vac, 60 cps, 50 watts. 8½ x 12½ x 7 in., 16 lb.—**Eico Electronic Instrument Co. Inc.,** 131-09 39 Ave., Flushing, N.Y.

ADAPTER, *Stradford model 480* picks up hi-fi signal in TV set, feeds it to amplifier, tape recorder or receiver, then reproduces hi-fi sound through speaker system. Tube clamp with 6-ft. wire placed around glass of sound detector tube in TV receiver, other end connected to adapter. Patch cord connected to auxiliary input of amplier or receiver or recording input of tape machine. 9 7/16 x 6 3/16 x 2¾ in.—**Truetone Electronics Inc.,** 14660 Raymer St., Van Nuys, Calif.



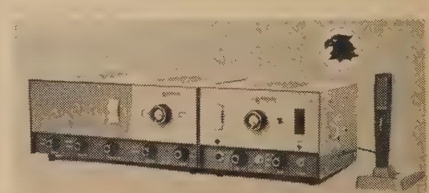
CENTER SPEAKER FOR STEREO, *Conar 38P.* L + R center signal from stereo system without additional crossovers or amplifiers. 12 full-range speakers. Response 40–17,000 cycles. 25 watts. 8 to 16 ohms. 25 x 20 x 5 in. Oiled walnut with anodized aluminum trim.—**Conar Instruments,** 3939 Wisconsin Ave. N.W., Washington, D.C. 20016.

STEREO AND MONO TAPE RECORDER, *Sony model 500,* 2 speeds, 2 infinite baffle speakers in split-lid of carrying case. Vertical or horizontal operation, stereo mixing of mike and line inputs for effects as "sing-along" recordings, sound-on-sound, automatic end-of-reel shutoff. Response ±2 db 50–14,000 cycles at 7½ ips, signal-to-noise ratio 50 db. Inputs: 2 microphone, 2 auxiliary. Outputs: two 600-ohm stereo line, two 8-ohm stereo external speaker, 8-ohm binaural earphone jack. 110 watts, 110–117 volts ac, 60 cycles.—**Superscope Inc.,** 8150 Vineland Ave., Sun Valley, Calif.

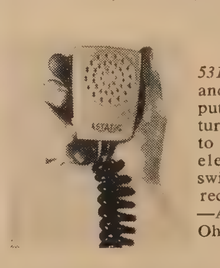


LIGHTWEIGHT TAPE RECORDER, *model 1600.* VU meter, index counter, microphone. Records at 7½, 3¾, 1⅞ ips; 2 track, monaural.—**Roberts Electronics Inc.,** 5978 Bowcroft St., Los Angeles 16, Calif.

CHANGER UNIT. *Studiomatic* record changer with *Feather Action Tone Arm.* Hinged cartridge adjusts automatically to external pressure, prevents excessive stylus force. Dusting pad rides ahead of stylus, muting switch takes out pickup noise during change cycle.—**RCA Parts & Accessories, RCA,** PO Box 654, Camden, N. J.



CB BASE STATION combines *Eagle R-27* receiver and *Eagle S-23* transmitter. *R-27:* rf gain control, selectivity switch, cascode nuvistor front end, 12 tuned i.f. coils. *S-23:* compression amplifier, clipper-filter stage, 23 channels, built-in SWR meter.—**Browning Labs, Inc.,** Dept. A, 100 Union Ave., Laconia, N. H. 03246



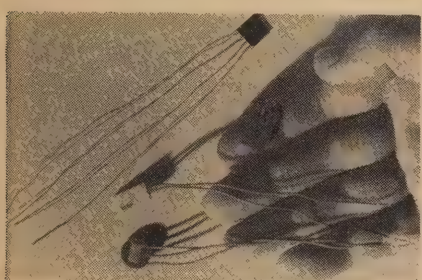
MICROPHONE, *model 531,* for ham, CB, mobile and base stations. High output –50 db. Wide temperature tolerance and immunity to humidity in Hi-Z ceramic element. Dpdt control switch. Gray plastic case, rectangular hang-up bracket. —**Astatic Corp.,** Conneaut, Ohio.

ALL-TRANSISTOR CAR RADIO, *model 707 Karadio.* 7 tuned circuits with rf stage, tone control, hand wiring, 5 x 3-in. elliptical speaker.

Fits-all universal design installation for under- or in-dash mounting. 5½ x 6½ x 2 in. 4 lb.—**ATR Electronics, Inc.,** 300 E. 4 St., St. Paul 1, Minn.

CB BASE-STATION ANTENNA, *Mark V*, for 27-mc Citizens-band service. 2 in-phase elements with feed point internally at center of antenna. Maximum vswr 1.2:1 at 290 kc. wide. 52 ohms. Cage around lower half of antenna is part of lower radiating element and acts as electrical sleeve–no radials. 20 ft. tall, terminated in uhf series SO-239 connector. Upper part aluminum, lower galvanized steel pipe. Universal mast mounting kit.—**B & K/Mark Div. of Dynascan Corp.,** 1801 W. Belle Plaine Ave., Chicago, Ill. 60613

PARABOLIC ANTENNAS for uhf TV. *Model D-1338T-72* uses type F 75-ohm coaxial output for frequency ranges 470–525, 525–700, 700–800, 800–890 mc. *Model D-1338T-300* (shown): 300-ohm air dielectric terminals. Covers 800–890 mc. -ft.-diameter antennas of ⅛-in. steel wire construction, ¼-in. cross-members and peripheral ring. Minimum gain 17 db over tuned reference dipole; front-to-back ratio 20 db minimum.—**Defense & Industrial Div., TACO,** Sherburne, N.Y.



SEMICONDUCTORS, Hall generators multiply magnetic field or device current to develop output voltage. Use as gauss meters, ammeters, wattmeters, function generators, choppers and position indicators. Voltages: 210 to 420 mv in 10-kilogauss field. Epoxy encapsulated, 0.375 x 0.375 x .023 in. One 225-mv unit is 0.55 x .05-in. disc. Ceramic-encased unit with linearity of 0.2% measures magnetic fields. 3 thin-film devices with outputs of 1.7, 1.5, 1.1 volts for position indicators and contactless switches.—**Special Products Dept., Westinghouse Semiconductor Div.,** Youngwood, Pa.

CERAMIC FUSES, *Picofuse series 275 and 276*, .078-in. diameter, ⁷⁄₃₂ in. long, up to 5 amps with interrupting capacity of 300 amps at 130 vdc. Fast-acting, cartridge shaped; 5 weigh 1 gram. *Series 275*, axial lead, *276* radial. Blowing characteristics, 100% 4 hr minimum, 200% 5 sec maximum. Can be soldered to within ¼ in. of end or snapped into diode type mounting. Ratings: ⅛, ¼, ⅜, ½, ¾, 1, 1½, 2, 3, 4, 5 amperes at 130 volts. —**Littelfuse, Inc.,** 800 E. Northwest Highway, Des Plaines, Ill.

ADAPTER, *model A-106* converts *model 1076* TV analysts to crystal-controlled keyed rainbow color display and more accurate horizontal syn-

chronization.—**B & K Mfg. Co., Div. of Dynascan Corp.,** 1801 W. Belle Plaine Ave., Chicago, Ill. 60613

FUSEHOLDER, *Buss HLF.* New compact waterproof type, ⅝ in long, extends 29/32 in. behind front panel. Takes ¼ x 1¼ in. fuse; converts to 9/32 x 1¼ in. fuse by simply changing screw-type knob. Military type meets all environmental conditions and requirements of MIL-F-19207A. — **Bussmann Mfg. Div.,** McGraw-Edison Co., University at Jefferson, St. Louis, Mo. 63107

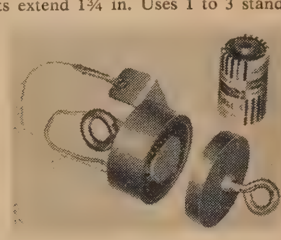
COLOR TV ANALYZER, *model 900,* tests for control-grid voltage, color-gun screen voltage and current, focus voltage, cathode voltage and emission, control-grid emission current. Measures to 7,000 volts on focus grid of color tube. Speeds up purity, convergence and gray-scale tracking adjustments.—**Mercury Electronics,** 111 Roosevelt Ave., Mineola, N.Y.

CB FREQUENCY METER, *type 17A4,* measures frequencies and field strength in 27-mc Citizens band. Self-contained batteries. Accuracy 0.001% at room temperature. Indicates deviation in kc on calibrated meter. Can be equipped with up to 4 crystals for measuring up to 12 CB frequencies.—**Budelman Electronics Corp., General Signal Corp.,** 375 Fairfield Ave., Stamford, Conn. 06902

PANEL METER, *model .5E.* ½ x 1¼ x 2¼ in. Acrylic plastic window needs only 0.625 sq. in. of panel area, 0.85-in.-long dial with maximum of 25 divisions. Accuracy ±2% of full scale for dc instruments, ±3% for rectifier type ac. Ranges from 50 dc μa to 1 amp, 10 dc mv to 300 v, 10 ac volts to 300 volts (rectifier type).—**Triplett Electrical Instrument Co.,** Bluffton, Ohio.

ALL-PURPOSE ELECTRICIAN'S TOOL *No. 1000.* Shears 6 sizes of bolts, strips wire sizes 10- through 22-gauge, cuts wire, gauges No. 4 through ⅜ in. studs, gauges wire sizes, crimps terminals. Plastic handles.—**Mathias Klein & Sons, Inc.,** 7200 McCormick Rd., Chicago 45, Ill.

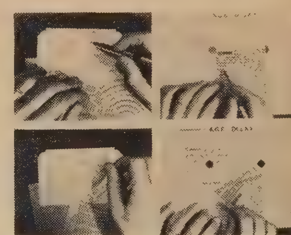
ELECTROMAGNET with magnet and yoke assembly, coil, battery holder and leads, alligator clips and eyebolts. Coil has 2-ohm resistance. Lifts up to 100 lb. Shell 1⅜ in. long, 2½-in. diameter, eyebolts extend 1¾ in. Uses 1 to 3 standard flash-



light batteries. Instructions. 2 lb.—**Edmund Scientific Co.,** 105 E. Gloucester Pike, Barrington, N. J.

ELECTRIC OUTLET CONTROL CENTER, *model CON-6.* Built-in fuse box, on-off finger-touch rocker switch control, line cord, 6 outlets.

Mountable or portable. 110–120 vac/dc, 1,500 watts, 15 amps.—**Fedtro Inc.,** Federal Electronics Bldg., Rockville Centre, N.Y. 11571



DRY-TRANSFER MARKING SYSTEM. *Meter and Dial Set* for marking control panels and meter dials includes arcs, lines, arrows, assorted rotary tap switch patterns for common angular detents. Twelve 5 x 7 in. sheets of arcs and 12-mil graduation lines for special and prototype meter dials. Black, white, red.—**Datak Corp.,** 63 71st St., Guttenberg, N.J.

ALL-TRANSISTOR RECITAL ORGAN KIT, *Schober Recital Organ.* Two 61-key manuals, 5 pitch registers on each manual, 4 pitch registers on pedals, 6 couplers (both intermanual and intramanual), 2 swell shoes, vibratos separate for 2 manuals, pedals sound without vibrato. Console: 55 in. wide, 29 in. deep without pedals—46½ in. including full-size AGO pedals. 43½ in. high plus 10-in. music rack. Full-length bench with curved front, heel rest, storage compartments. Walnut finish. 250 lbs. All transistor; no tubes. Printed circuits except power supply; gold switch contacts. Preassembled, hand-finished woodwork. Features "Library of Stops"—any or all 32 voices can be changed. Only 12 tuning adjustments.—**Schober Organ Corp.,** 43 W. 61 St., New York N.Y. 10023

VARNISH, *Anti-Fungus* gives protective coating with dielectric strength of 2,000 v/mil on all surfaces of electronic assemblies. Recommended for hot and humid climates. 16-oz. spray can or gallon cans.—**Injectorall Co.,** 6 Bay 50th St., Brooklyn 14, N.Y.

All specifications from manufacturers' data.

technicians' News

NEA Meets to Promote Merger with NARDA

Indianapolis — Independent service dealers from 10 states gathered here during March in the first 1964 board of directors meeting of the National Electronic Associations, Inc. (NEA). States represented were Arkansas, Indiana, Iowa, Kansas, Michigan, Minnesota, Nebraska, North Carolina, Ohio and Texas.

NEA is the national representative for about 2,000 radio–TV–electronic servicers in America, according to organization spokesmen. Its members are affiliated state service associations.

Chief topic at the meeting was the proposed merger with the National Appliance & Radio–TV Dealers Association (NARDA). There was considerable debate about the form that the merged association would take, particularly with regard to the relative dominance of the dealer division or the service division. Ultimately, the original "separate but equal" proposal was tentatively agreed on by both groups. (See "NEA Seeks Merger . . .", Technicians' News, April 1964, page 92.) However, definite and final action was reserved for a later meeting.

Other developments to come under scrutiny at the meeting were alleged price discrimination by a major tube manufacturer in establishing a dual price structure for different retailers in the Indianapolis area, and quality stabilization legislation.

NEA is endorsing and strongly supporting the quality stabilization bill, intended to establish minimum retail prices in the radio–TV industry.

Any state association that wants assistance in expanding or in any other field is urged to write Gregory Barkoukis, President, National Electronic Association, 341 W. Bowery St., Akron, Ohio 44307.

"Custom-Built" Tubes May Offer Replacement Problems

A new approach to vacuum-tube design revealed by General Electric may have an interesting effect on your tube stocks. Described in detail in "New Semiconductors and Tubes" (page 75, May RADIO-ELECTRONICS), the new concept involves stockpiling quantities of a few basic vacuum-tube functional elements (diode, triode, pentode sections) and combining them in relatively small lots to suit a manufacturer's specific needs.

That way, a set maker would not be restricted to existing compactron combinations, but could more or less tailor tubes to fit set design. Small-volume manufacturers would benefit particularly by being able, perhaps for the first time, to use custom tube designs they could not have afforded previously. Yet engineers would still be working with familiar tube sections (like 12AX7 type triodes, etc.)

Prospects are somewhat overwhelming for the service technician, who can see instances of these unique tubes manufactured in quantities of 10,000 or less, with the resulting near-certainty that the

end products would be so widely scattered that it would be impractical for distributors to stock replacement tubes.

Possibly G-E engineers can come up with a universal replacement tube, or maybe a compactron base carrying multiple sockets into which any desired combination of miniature tubes might be inserted?

How Many Transistors in a 6-Transistor Set?

There's more than one way to build a six-transistor radio. Might be worth looking into, suggests *TESA News*, the St. Louis association's publication. Not all sixes perform at the same level.

At any rate, don't just count the number of "i.f." cans. One of the most recent "developments" (retrogressions?) has been to eliminate one i.f. stage (most sixes have two i.f.'s). Yet you may still find three shield cans: one contains the oscillator coil.

A six-transistor set with only one i.f. stage relegates the sixth transistor to the audio department. That way, the set gives lots of volume on local stations, but reception in low-signal areas is noticeably poorer.

To manufacturers, the single i.f. stage means a simpler, cheaper set, easier and faster to assemble and align.

Another cost-cutting approach is to use a defective transistor instead of a diode as the detector. Under US regulations, a defective transistor used as a diode can still be called a transistor. Thus there are six-transistor sets on the market with only five amplifying transistors. The sixth is a defective one, ordinarily discarded, and costs the manufacturer nothing. He saves the cost of a diode.

It isn't a new trick—just a new wrinkle on a very old one. Remember the sets with dummy tubes?

Justifying Your Estimate Fee

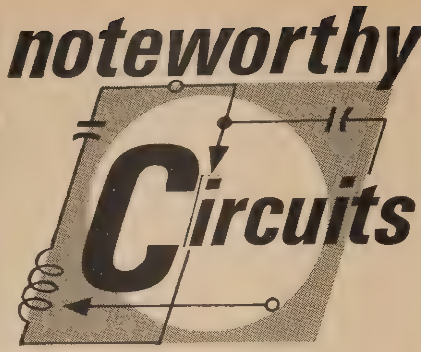
If your customers gripe when you announce that you charge for an estimate, you might do what one shop in Tallahassee, Fla., did. Cited as the "Business Idea of the Month" in the January 1964 NATESA *Scope*, the back of a business card printed for Ramm's TV & Radio Shop gives ten reasons why they charge for estimating.

1. To make estimates takes time.
2. Our income is rated by hourly pay.
3. Locating trouble is the greater part of any repair job.
4. We are definite in our diagnosis —no guesswork.
5. Our expense goes on whether we estimate or repair.
6. Our knowledge has been costly. We did not get it free.
7. Equipment must be maintained and estimating helps wear it out.
8. A TV, radio or phonograph must be made to operate in order to complete diagnosis.
9. Testing charges are waived when services are paid for.
10. We expect only what you expect if you work for a living. END

Papers Sought for Automotive Electronics Conference

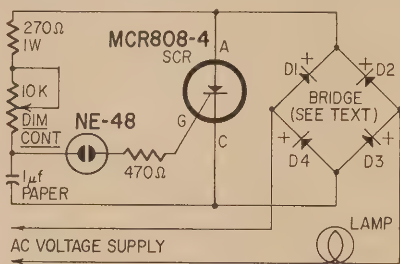
The First National Conference on Automotive Electrical and Electronics Engineering, sponsored by the Southeastern Michigan section of the IEEE, is seeking original papers on electronics as applied to vehicles and traffic. Deadline for 500–1,000-word abstracts is July 15. Write: Chairman of the Papers Committee, Mr. E. A. Hanysz, General Motors Research Laboratories, G.M. Tech Center, Warren, Mich. Indicate the approximate time required for presentation and discussion.

The conference is to take place Sept. 22 and 23 in Detroit, at Wayne State University.



Electronic Light Dimmer Improved With SCR

There are a number of basic electronic light controls. Only a few cover a range of brilliance from full to zero without a tricky switching arrangement.



The simple circuit shown here was taken from a *Motorola Application Note* on the MCR808 series of silicon controlled rectifiers. Full brilliance control is obtained by using a full-wave bridge to supply the load (lamp). This makes it possible for a simple phase shift network to control the SCR over both halves of the ac cycle. The neon lamp provides more positive and repeatable triggering than is possible with R-C or resistance divider networks alone.

The SCR is a Motorola MCR808-4. The full-wave bridge is made up of 200-volt, 18-ampere rectifiers. D1 and D2 are MR324's and D3 and D4 are MR-324R's with reverse polarity.

Power Supply for Transistor Sets

Home-made bench power supplies often use heavy power transformers salvaged from old radios or TV sets. Filament windings are brought out to terminals on the panel but are seldom used. An article in *Revista Monitor de Radio e Televisao* (Sao Paulo, Brazil) shows how these windings can be used to supply low dc voltages for servicing or testing transistor sets that draw up to 35 ma or so.

The circuit is shown in Fig. 1. Two 6.3- volt windings or one 6- and one 5-volt winding are connected in series-aiding and then rectified to provide a maximum of around 9 volts. A voltage divider provides lower voltages commonly used in transistor circuits. The bridge rectifier consists of four 130-volt rms, 500-ma silicon diodes of the type normally available for 40–50 cents each on electronic parts bargain counters.

The voltage divider was made by

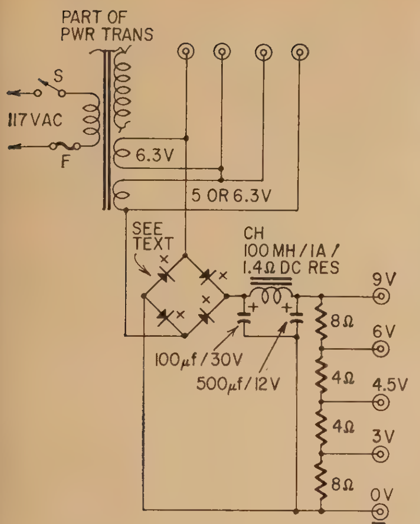


Fig.1

winding No. 27 Nichrome V wire on a mica strip approximately 0.8 in. wide and about 8 inches long (Fig. 2). This wire has a resistance of 3.228 ohms per foot, so you will need around 8 feet. You may be able to purchase enough wire

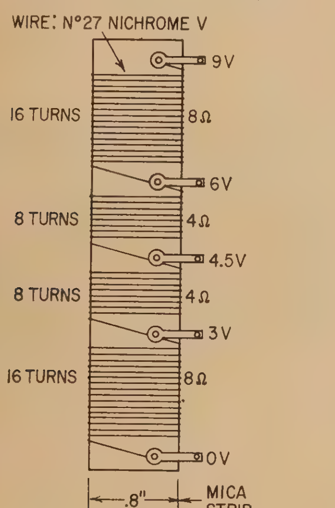


Fig.2

from a local firm that repairs industrial electric heaters and elements. If not, write to Magnet Wire, Inc., 25 Walker St., or Industrial Heater Co., both in New York, N. Y. END

Correction

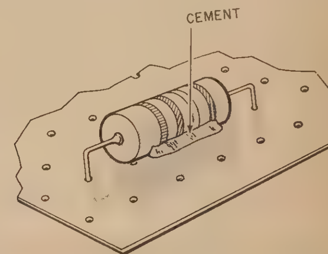
In "Take-Along Transistor Amplifier" on page 32 of the April issue, the Knight transformer is suitable as T1, but the author used a Hammond 125-B, not a 147-N as mentioned. The 147-N was used as the output transformer in the author's version. Price for the 125-B, 147-N pair is $5.75 plus postage.

Larger versions of these transformers may give somewhat better response: the 125-D and 147-U, for which the price is $11.43 together plus postage.

The author tells us also that a 500,000-ohm pot as R1 will give better bass from most crystal and ceramic cartridges.

Cement Holds Parts

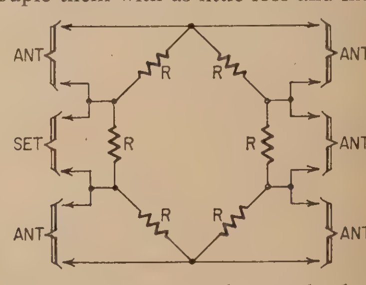
For economy, I often reuse parts unsoldered from printed circuits. The leads on these parts are usually too short to bend to hold the part in place on a new circuit board or vector board.



Use a little dab of rubber cement to hold such parts in place before soldering. This does not interfere with the circuit and the part can once again be removed by desoldering for future use. *—Tom Jaski*

Splitting Pad Matches Multiple Antennas

In many rural areas, TV stations are located at great distances and in several directions. This sometimes means using several separate directional antennas, and then you need a way to couple them with as little loss and inter-



ference as possible. I have solved this problem by reversing a circuit used to attach several sets to one antenna.

One good coupler–matcher consists of a series loop of resistors, one to shunt each antenna and one for the output. The resistors are all of equal value, and the formula for calculating that value is

$$R = \frac{NZ}{N-1}$$

where R is the value of each shunt resistor, Z is the desired impedance to match the set's input and N equals the total number of resistors.

For example, suppose you wanted to couple five 300-ohm antennas to a 300-ohm TV set input. You'd need six resistors.

$$R = \frac{(6)(300)}{6-1} = \frac{1800}{5} = 360 \text{ ohms}$$

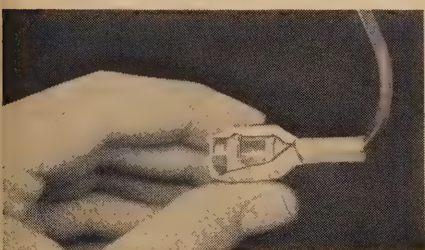
Of course this can be used for any number of antennas, and any impedance. *—William R. Seabrook*

[The writer's application for this pad is less common than the opposite one he mentions: matching several sets to one antenna. The same formula applies as long as all effective impedances are equal. Note, too, that the pad is inherently balanced, and cannot be used with a coaxial system unless baluns are used also.

A broad-band booster at the set will help make up for losses in the matching pad.*—Editor*]

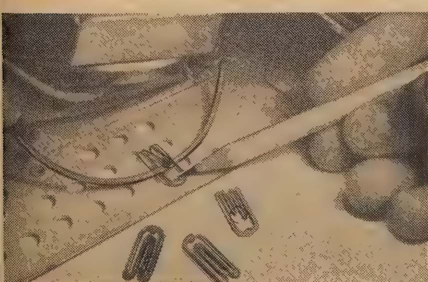
Auto Radio Fuses

It's a real nuisance to lose the fuse from an auto radio when you remove the unit for repair or inspection. To avoid this, tape the fuse right in the holder with a piece of masking tape as shown. Then, it'll always be there when the time comes to reinstall the radio. Furthermore, there'll never be a doubt as to what value fuse belongs in the line.



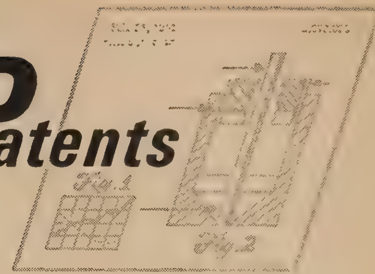
If you are ever in doubt about whether the fuse is the correct value, always check the radio manual. Carelessness here can result in unnecessary damage to the radio.*—Ronald S. Newbower*

Paperclip Wire Anchor



To reduce the effects of changing lead capacitance and inductive coupling effects in high-frequency circuits, anchor small wire leads with plastic paperclips like the ones shown. Cement the clip to the chassis or some part and slip the wire in place. The clips are made of high-dielectric plastic and do not cause serious losses.*—John A. Comstock* END

new Patents

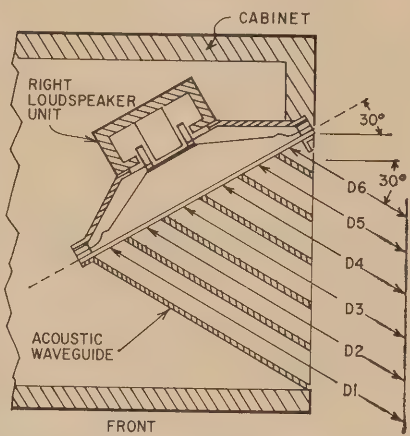


Stereophonic System

PATENT No. 3,105,113

Harry F. Olson, Princeton, N. J. (Assigned to RCA)

Good stereo requires ample spacing between speakers. This patent shows how to increase the *effective distance* between two speakers placed inside a small table cabinet.



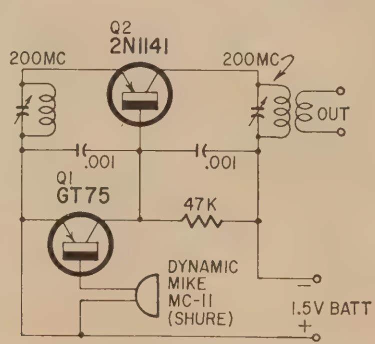
The speakers are directed to project sound from the ends of the cabinet. The closeup view shows the acoustic waveguide built between speaker and cabinet. Sound must move through the narrow channels to reach the room. Regardless of which channel the sound traverses, the distance between speaker and point P will be the same (because of the 30° relationships). Therefore, P is a *virtual source* of sound, as judged by a listener.

In a typical setup, the cabinet was 30 inches wide, so the actual spacing between 8-inch speakers is only 20 inches. Yet the *effective* distance was 38 inches!

Low-Power Transmitter

PATENT No. 3,108,234

Arthur G. Burns, Yorktown Heights, N.Y. (Assigned to General Precision, Inc.)



This simple transmitter can send signals hundreds of feet. It puts out both FM and AM at 200 mc.

Output from the microphone causes changes in the resistance of Q1, so it varies the bias of Q2. In turn, this controls the collector–base capacitance of Q2 and the output frequency.

The resonant tank in Q2's emitter may be replaced with a choke coil.

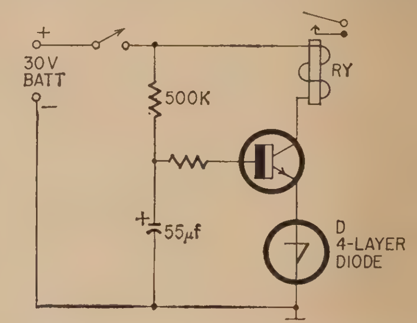
Long-Time Delay Circuit

PATENT No. 3,089,953

Joseph R. Herr, Palo Alto, Calif. (Assigned to Sylvania Electric Products, Inc.)

In this patent, a transistor makes long time delays possible without large capacitors: 30 seconds with the values shown.

When the switch is closed, the capacitor charges through the high resistance. The positive



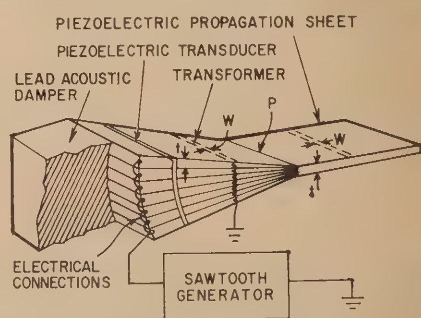
bias causes the transistor to conduct. When emitter current exceeds a critical value, it fires a 4-layer diode (D). Then full current flows into the relay winding to close the contacts.

The resistor in the base circuit is selected to limit base current to a safe value when diode fires.

Acoustic Transformer

PATENT No. 3,112,414

Stephen Yando, Cold Spring Mills, Huntington, N.Y. (Assigned to General Telephone & Electronics Labs, Inc.)



This transformer is suitable for stepping up acoustic pressure, and may be used in connection with ultrasonic delay lines or display devices. Seven wedge-shaped zinc elements are insulated from each other by Teflon. Each is divided into two parts by a thin transducer made of piezoelectric material, like lead titanate-lead zirconate. Each transducer is excited by a sawtooth generator putting out about 100 volts peak-to-peak.

Acoustic pulses originate at each transducer. The waves to the left are damped out by a lead termination. Waves moving to the right meet at P and combine to form a pulse multiplied by $\sqrt{7}$, where 7 is the number of wedges.

The thickness (t) of the piezoelectric propagation sheet is equal to the height of each transducer for optimum matching. Each transducer must be thin if narrow pulses (w) are to be propagated. Here are typical values:

Propagation velocity 3,600 meters/sec
Sawtooth rise-time 3 μsec
Output pressure 1 newton/sq mm
w = 3.6mm t = 0.75 mm

Tube-Transistor Gate

PATENT No. 3,105,196

Harold Lerner, East Paterson, N. J. (Assigned to General Precision, Inc.)

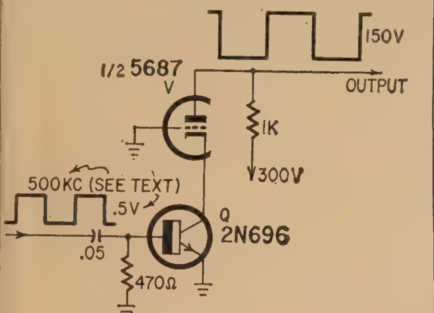


Fig.1

A low voltage controls much higher voltage in this hybrid circuit. A square wave, for example 0.5 volt at 500 kc, switches Q on and off. V conducts at the same rate, but provides much greater output. V may be both sections of a 5687 in parallel (Fig. 1).

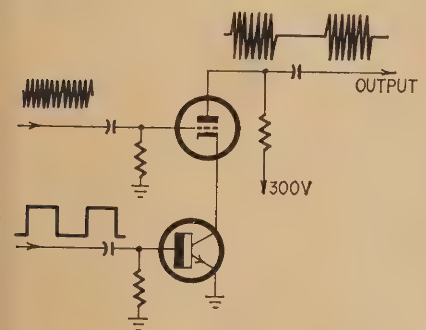


Fig.2

The grid may be used as a second input terminal. For example (Fig. 2), a 30-mc signal may be fed to the grid, a 500-kc square wave to the base. Output will be rf pulses during conduction intervals.

Alphabet Study Machine

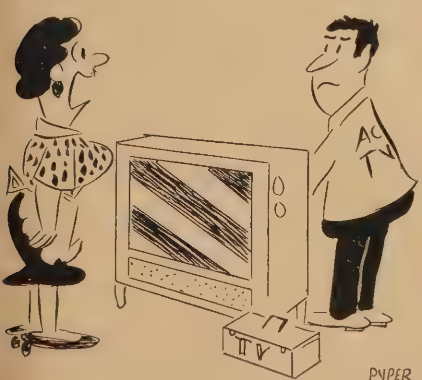
PATENT No. 3,112,569

Omar K. Moore, Guilford, Conn. and Richard Kobler, W. Orange, N. J. (Assigned to McGraw-Edison Co., Elgin, Ill.)

This is a combination of a typewriter and a tape machine to aid youngsters to learn the alphabet. When the child presses a key, the letter is printed. After a time delay (which is under control) the letter is pronounced. This gives time for the child to pronounce it himself first, if he can.

The sound is reproduced by a drum that carries as many tracks as typewriter characters. Each key selects the proper track. Upon pressing the upper-case shift key, the tape pronounces the words "upper case".

An important feature is that the machine remains locked after a key is pressed, until the machine has spoken. END



"Maybe if you turned the catty-corner control. . . ."

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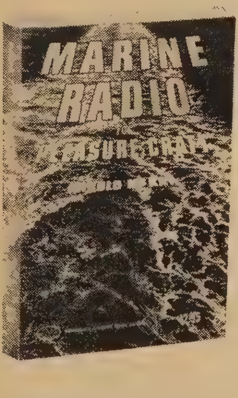

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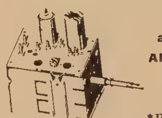

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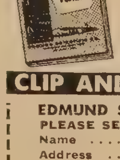

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☐ 6	400	59¢	☐ 25	50	.99	☐ 50	100	2.95
☐ 6	600	69¢	☐ 25	100	1.29	☐ 50	200	3.75
☐ 6	800	89¢	☐ 25	200	1.60	☐ 100	25	2.15
☐ 6	1000	95¢	☐ 25	300	1.75	☐ 100	50	2.59
☐ 12	50	49¢	☐ 25	400	1.95	☐ 100	100	3.10
☐ 12	100	69¢	☐ 25	600	2.50	☐ 200	25	3.25
			☐ 35	50	1.25	☐ 200	50	4.10
			☐ 35	100	1.49	☐ 200	100	4.95

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TERMS: send check, money order, include postage—avg. wt. per pak 1 lb. Rated, net 30 days. CODs 25%

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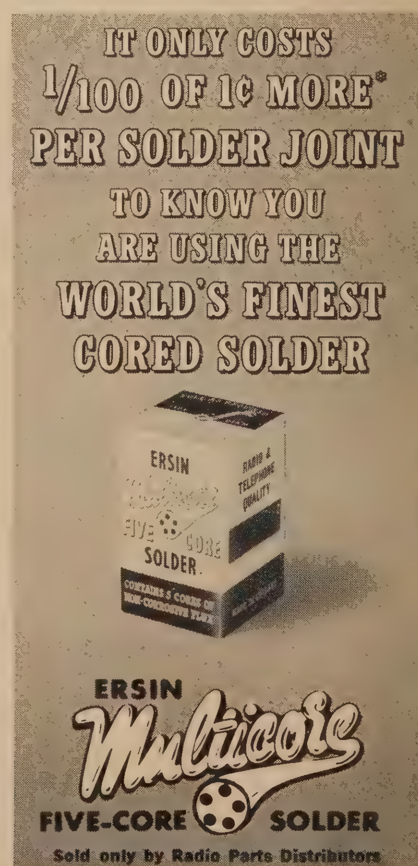

*Based on cost comparison in current catalogs.
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Classified Ads

Rates—55¢ per word . . . minimum 10 words. Payment must accompany all ads except those placed by accredited advertising agencies. Misleading or objectionable ads not accepted. Copy for August issue must reach us before June 14th. Figure one word: name of city (New York name of state (New Jersey). Sets of characters as in key (741-RE), also abbreviations as 8x10 mm, A.C., D.C., C.O.D. Hyphenated words not normally considered such count as two words (Hi-Fi). ZIP CODE FREE. RADIO-ELECTRONICS, 154 West 14 St., New York, N. Y. 10011.

Audio—Hi-fi

TAPE recorders, Hi-Fi components, Sleep-learning equipment, Tapes, Unusual values. Free catalog. **DRESSNER,** 1523 Jericho Turnpike, New Hyde Park 5, N.Y.

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HI FI, Ham Equipment, Discount Catalog, **MENDOTA CAMERA SHOP,** Mendota, Minn.

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WOODEN TOP is a "spinning fool"; has a record spin of twelve minutes and has been clocked at an hour and a half. Also spins upside down. Small fry from 2 years up can handle it, but it really winds up at adult parties, Handmade of Tennessee beech. $1.50 ppd. **HELEN BULLARD,** Ozone, Tenn.

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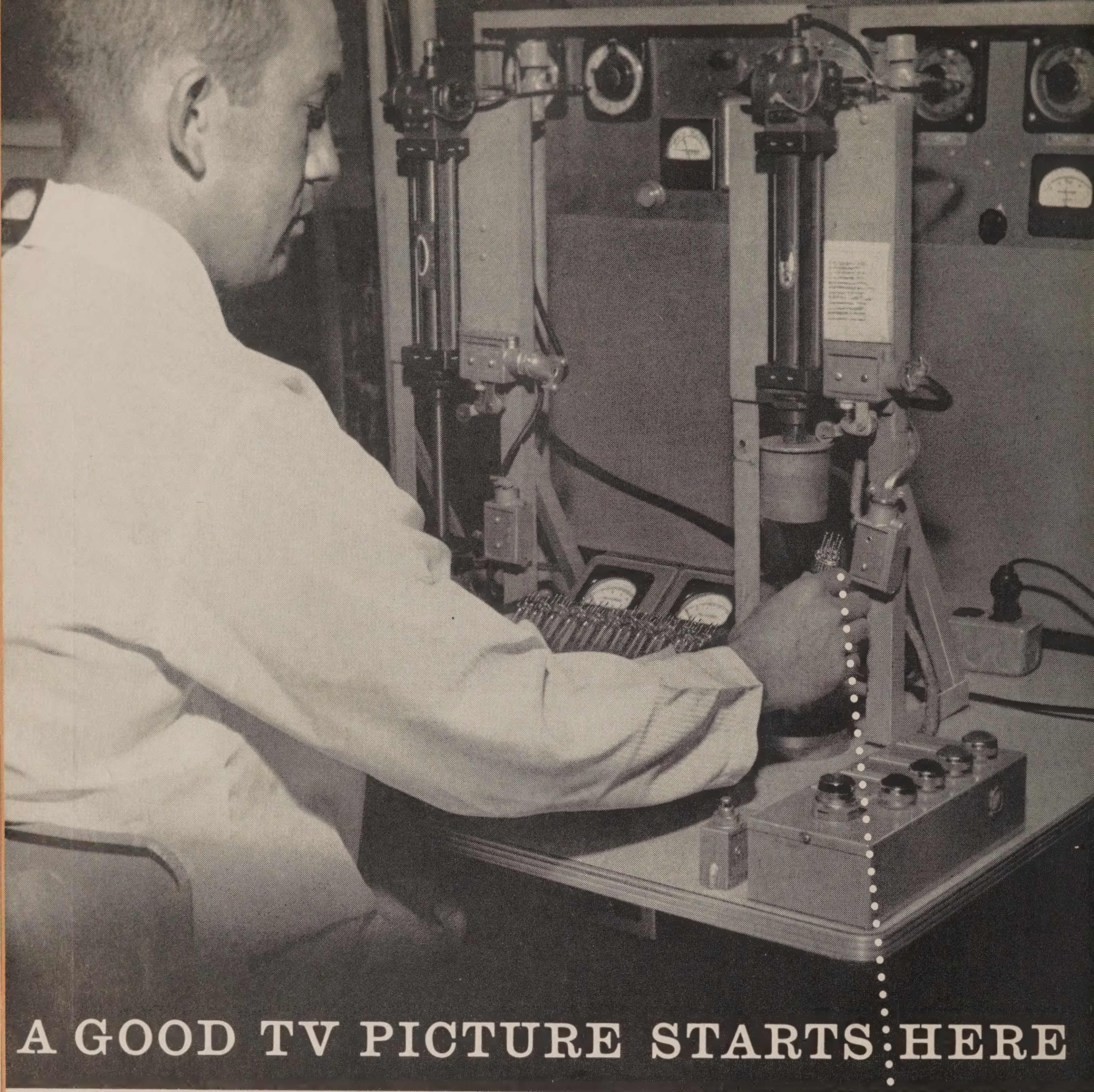

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It Depends on a Leakproof Stem Seal

The slightest leakage of air weakens the high vacuum of a TV picture tube...resulting in a costly callback and a dissatisfied customer for you. This is why RCA takes extra precautions to maintain the vacuum in Silverama picture tubes.

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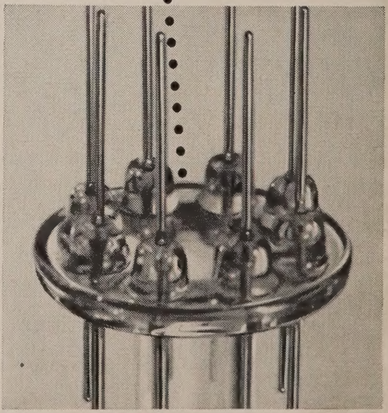

Stem assemblies are tested on a special high-vacuum leak detector. Detector is a helium mass-spectrometer, detecting passage of helium "tracer" gas through any of the glass-to-metal seals. A stem assembly passing this rigorous test is ready to become a vital part of an RCA Silverama® Picture Tube.